Established 1916 as THE OIL WEEKLY

SEPTEMBER, 1956

WORLD OIL

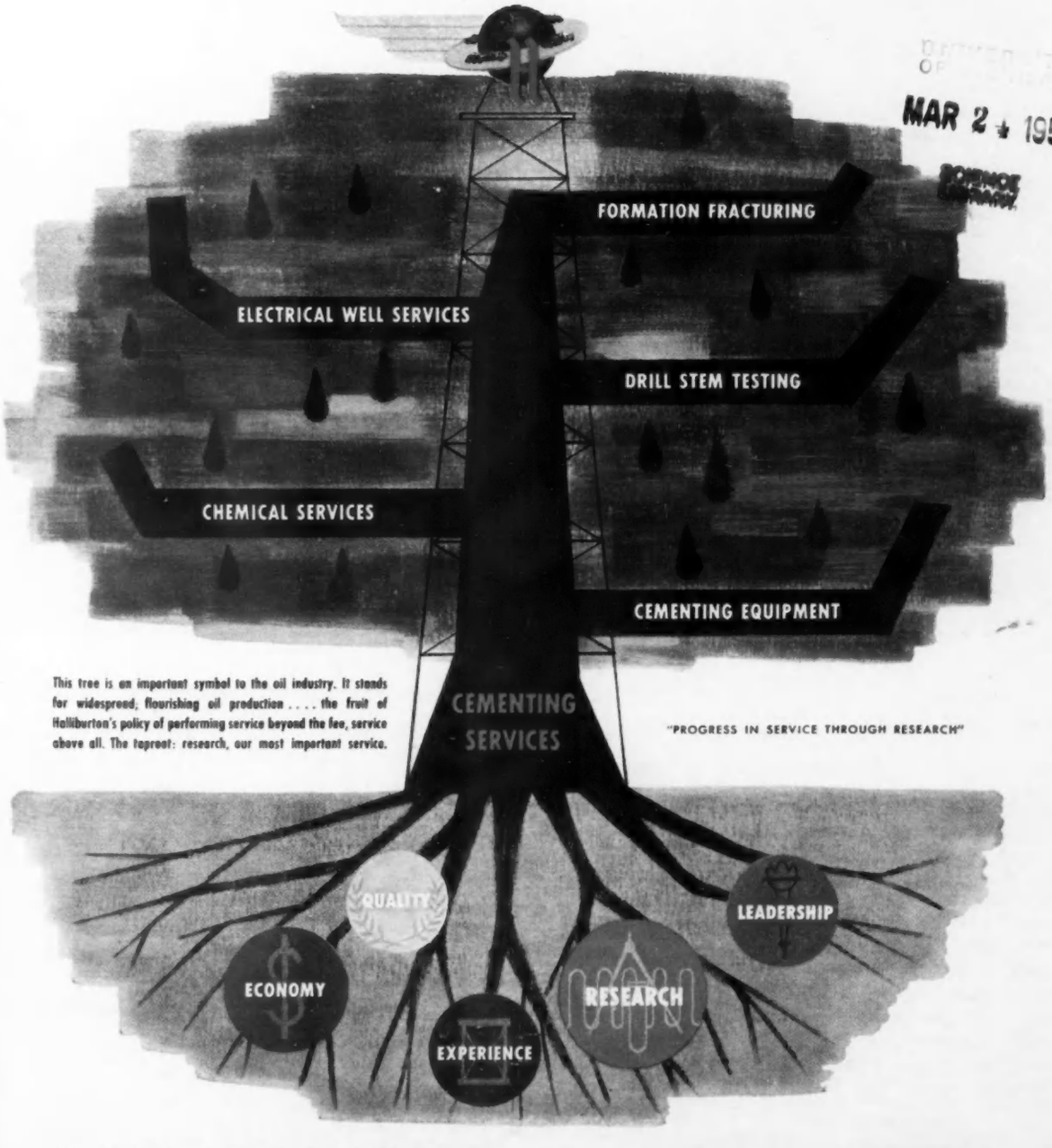
SPECIALIZED FOR EXPLORATION, DRILLING PRODUCING OPERATIONS AND MANAGEMENT

Gulf Publishing Company $2 Per Year; 50 Cents a Copy

IN THIS ISSUE . . .

- **Special Report on Water-Flooding**
- **More about low density cements**
- **Soviet giving education top priority**

THE HALLIBURTON TREE OF SERVICE



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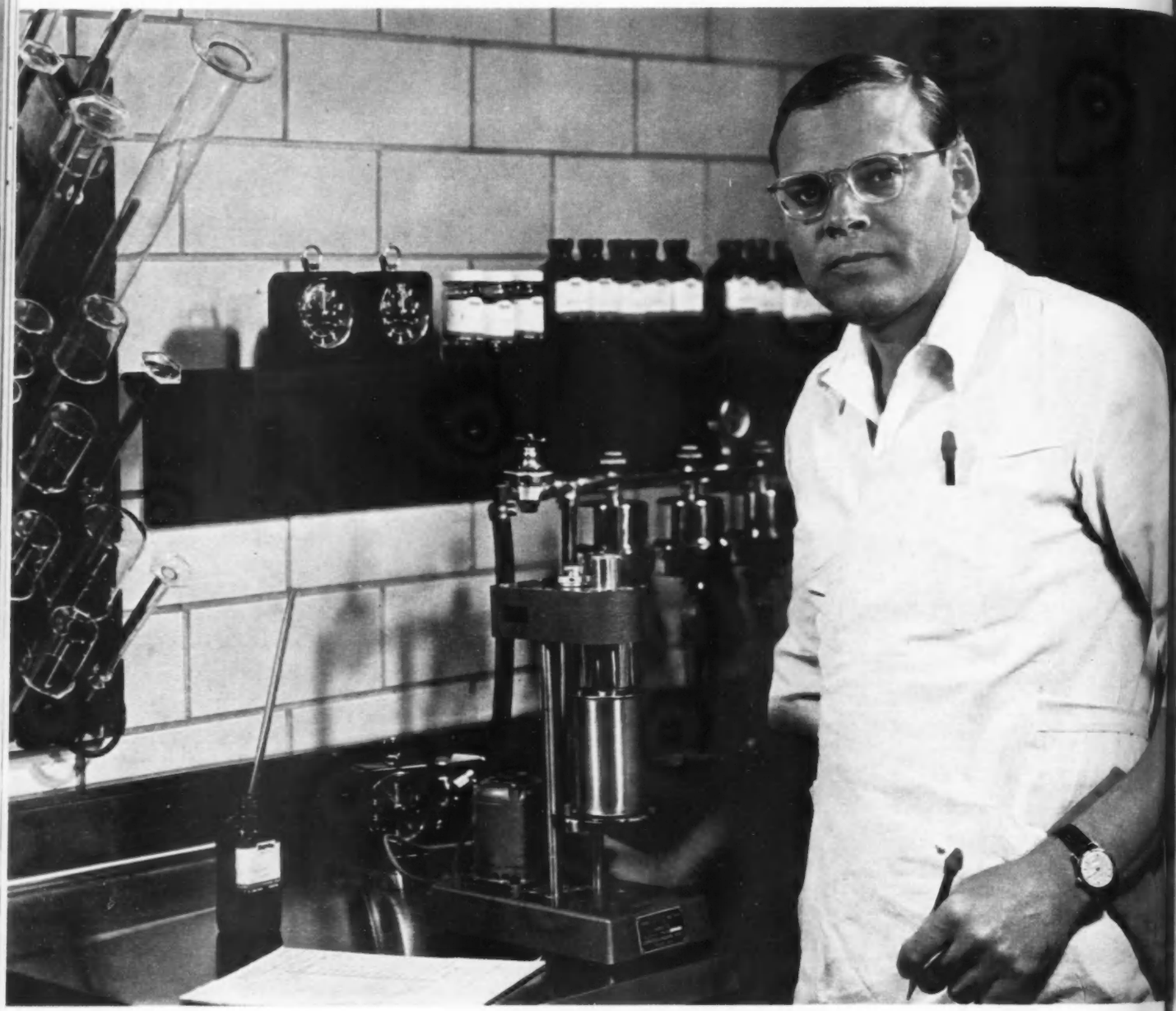

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DRILLING MUD SERVICE

MAGNET COVE BARIUM CORPORATION
Houston, Texas

Volume 143, No. 4 September, 1956

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WORLD OIL

Established 1916 as The OIL WEEKLY

a quick look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

CURRENT OUTLOOK

☐ **Oil companies have had comparatively good earnings** so far this year. In the second quarter, 46 oil companies had net income of almost $3¼ billion. That was 15.4 percent more than they earned in the June quarter last year. For full details, turn to **Page 78. Second Quarter Earnings Up 15.4 Percent for 46 Oil Companies** ... **L. J. Logan**

☐ **In unitizing a large block of acreage** for repressuring or other purposes, the normal procedure is to send land men to contact the royalty owners. This is expensive and time consuming. When Cities Service Oil Company decided to unitize the Wilcox sand in Oklahoma City for water-flooding, the company and its partners decided to try a direct mail approach. This was most successful, and it is the first time in the history of the industry that it had been tried for such a large project. Turn to **Page 80. Direct Mail and Electronic Machines Replace Land Men in Unitization** ... **Anthony Gibbon**

☐ **The West—particularly Europe**—stands to suffer heavy economic losses should Nasser-inspired nationalism spread through the Arab oil producing countries. But, the economic stakes for the Middle East are even higher. For a timely analysis of both sides of the Middle East turmoil, read . . . **A Case of Double Jeopardy . . . Page 82** ... **Don E. Lambert**

☐ **The long entertained hopes** of profitably extracting oil from shale may be near realization. Promising methods have been developed by the U. S. Bureau of Mines. Engineers believe that it soon may be possible to produce oil from shale at practically the same cost that crude oil is being produced in many

Turn to Column 2, Page 4 ▸

Smiling Soviet scientists and Author Eby. (See Page 238).

We didn't use mirrors . . .

DR. J. BRIAN EBY, a special editorial representative of WORLD OIL, made use of the mirror in the background when he shot the picture above of smiling Soviet scientists in Moscow. But we *didn't* use mirrors when we set out to get the latest and most complete information on the oil industry in Russia and the satellite countries.

Two years ago, WORLD OIL Publisher Ray L. Dudley, sensing the need for oil men to acquaint themselves first hand with the Russian oil industry, began to lay the groundwork to get the real story.

His efforts paid off this summer when WORLD OIL sent Dr. Eby, well known Houston geologist, behind the now slightly parted Iron Curtain. Dr. Eby spent three weeks in Moscow talking to . . . and listening to . . . Russian oil experts. Dr. Eby's first report appeared in the August 15 International Outlook Issue of WORLD OIL. Included was exclusive information on Russian oil production and the Russian turbodrill.

In this month's International Section (**Page 238**), Dr. Eby gives his second report in which he tells how the Russians are pouring huge sums of money into expanding educational facilities, with special emphasis on petroleum geology and petroleum engineering. Don't miss this and the following installments on the oil industry in Russia, exclusively in WORLD OIL.

Water-Flood Importance Is On the Increase

The importance of water-flooding as a means of producing petroleum is increasing daily. It is estimated that a total as high as 25 percent of the U. S. production could be water-flood production by 1956. If this is the case it is important for management, engineers, field men, and all production personnel to become more familiar with the various aspects of this process.

This collection of articles is presented to provide WORLD OIL readers with some of the current available information on water-flooding. To be of service to people in every branch of production activity, a variety of material is made available. Grouped under the general headings *water-flood techniques* and *water-flood equipment* they present factual information of an operational nature.

CURRENT OUTLOOK *continued*

U. S. fields. A competitive cost for shale oil would require volume throughput and a continuous retorting operation. For details see **Pages 84 and 86**

☐ **The modern trend to glorify retirement** and hobbies has created a new philosophy—a philosophy that may not be good. For a humorous, thought-provoking discussion of the fad that has made it unfashionable for a man to like his work, turn to **Page 90. The Retirement Fad . . . Is It Good or Bad? . . . Dr. Allan James Fleming and Dr. C. A. D'Alonzo**

☐ **Suggestion systems are relatively new** to the oil industry. In fact, only a short score of oil companies have an organized suggestion plan. Here is a candid appraisal of the reasons why the oil industry is lagging behind in making profitable use of employe ideas—plus many excellent arguments in favor of suggestion systems. Turn to **Page 96. How Can a Company Lose? . . . . . William S. Wilcox**

☐ **An analysis of the world tanker fleet** reveals that the aging, declining U. S. tanker fleet will lose its first-place position and drop to third behind Britain and Norway by 1960 unless current trends are reversed. While the American tanker fleet continues to decrease, the world's fleet, sparked by recent in-

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 23, 1916, at post office at Houston, Texas, under the act of March 3, 1879.

☐ **There is no guarantee** that a water-flood will be a success. But here is a guide to determine whether or not a water-flood project is feasible. **Evaluation of Water-Flood Prospects. Page 174**..... **Paul J. Shanor**

☐ **More water-flood oil** was the objective of recent tests in Pennsylvania. Results of this research, important to future flooding operations, are presented on **Page 174. More Oil from Water-Flooding?**..... **Dr. H. G. Botset**

☐ **Hot water, when it deals with flood water injection,** can be helpful. Turn to **Page 186** for a report on operation, results and economics of installing a downhole electrical device for heating injection water. **Hot Water Injection Increases Water Input Rates**.....**J. N. Breston and B. R. Pearman**

☐ **Value of detergents in water-flooding** has been proved in field tests. Find the answers to your questions about the results of those tests on **Page 196. Have You Tried a Water-Flood Detergent?**.....**H. N. Dunning, R. T. Johansen, C. J. Walker, J. D. Powell and H. W. Watkins**

☐ **An open-type water conditioning** and injection system, used effectively by Tidewater Oil Company, is described as it was built. For a close-up of the project—the design, construction and operation—turn to **Page 206. A Water-Flood . . . From the Ground Up**.....**William H. McPhail**

☐ **Water treatment is of vital concern** in flooding operations. A discussion on **Page 216** of design, selection and operation of diatomite filters gives production men a close look at one phase of this treatment. **Some Tips on Diatomite Filters**.....**C. R. Bell and T. M. Jackson**

☐ **Prefabricated asphalt** exposed linings have proved successful in combating seepage from ponds in open-type water-flood systems. The method of installation, approximate cost and other facts are presented on **Page 224. Preventing Seepage in Open-Type Ponds** **Al Gaston**

☐ **Pump selection and maintenance** are of prime importance in the design and operation af a water-flood. See **Page 233. What Injection Pump Fits Your Operation?** .....**George C. Logan**

creases in the Norwegian and Liberian fleets and by Britain's shipbuilding boom, continues to gain in ships and tonnage and will increase by more than 25 percent by 1960. For a complete analysis of the world's tanker fleet, read **U. S. To Lose No. 1 Rank in Oil Shipping, Page 100**

EXPLORATION ARTICLES

☐ **Evolution and formation of hydrocarbon liquids,** influence of bacteria in the mechanics of fluid formation and the reasoning behind oil movement within a structure are described—particularly for the geologist and geophysicist—in the article, **Time Accumulation and Evolution of Hydrocarbons. Page 113.** ..... **William C. Gussow**

☐ **For an all-inclusive look** at the latest interpretation of the Simpson group in Oklahoma, turn to **Page 118, The Simpson Group Along the East Flank of the Anadarko Basin**.....**Ralph W. Disney and Charles E. Cronenwett**

DRILLING ARTICLES

☐ **Slurries having pressure insensitive densities** can be made with diatomaceous earth, water and Class A cement. Consideration must be given to reduced strength and modified thickening time obtained with the various formulations. For up-to-date information, read **Low Density Oil Well Cements. Page 131. F. J. Shell, J. R. Hurley, W. E. Bergman and H. B. Fisher**

☐ **Operating characteristics of torque converters** and hydraulic couplings are compared in Part 2 of the article, **Trend Toward Large Rigs and Fluid Driven Pumps.** Turn to **Page 144** for a summary of the advantages and disadvantages of each of the devices. **H. L. Willke**

☐ **Modification and new design** is revolutionizing drilling rigs in the far North. Power subs, engine and mud alarms, automatic drillers and hydraulic rotary drive are some of the innovations being tested for service in the extremely cold and rugged country. For details see **Page 156. What's New in Canadian Drilling Rigs**.....**F. M. J. Valint**

INTERNATIONAL ARTICLES

☐ **Remoteness of Brazil's oil discovery** in Amazon area is hindering progress, but drilling and exploration is continuing. For an evaluation of the country's current oil industry, turn to **Page 237. 2 Rigs, Exploration Parties Active in Remote Amazon**..... **H. T. Brundage**

☐ **The St. Lawrence Lowlands,** long known as a potential gas and oil area, is experiencing an exploratory reawakening. Turn to **Page 246** for the reasons why business is picking up in this previously neglected corner of the continent. **St. Lawrence Lowlands Drawing Renewed Interest**.....**E. Francott**

Turn the page for a Quick Look at what's ahead in WORLD OIL ➡

NEXT MONTH . . .

Months of research going

into next month's . . .

Drilling Progress Issue

FOR MONTHS, we've been studying ways to help the drilling contractor get the best return from his operation . . . and how his predicament affects the oil industry as a whole.

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- How to plan a profitable drilling operation
- What fringe costs to consider for realistic bidding
- What to expect in the rig of the future
- How to compare initial costs, depreciation methods and replacement of equipment

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So, be sure to look for your copy of WORLD OIL's Drilling Progress Issue.

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WORLD OIL and THE COMPOSITE CATALOG for the drilling-producing industry.

PETROLEUM REFINER and THE REFINERY CATALOG for the refining-natural gasoline-petrochemical industry.

PIPE LINE INDUSTRY and the PIPE LINE COMPOSITE CATALOG (first edition to be issued in July, 1957) for the oil and gas pipe line industry.

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Indexed by Industrial Arts Index Engineering Index

Oil Financing from the **FIRST** *in* **DALLAS** *goes where you go...*

Russell Guffey on drilling site of Cooke County, Texas, operation. He is brother and partner of Roy Guffey, Roy Guffey Drilling Company, Dallas.

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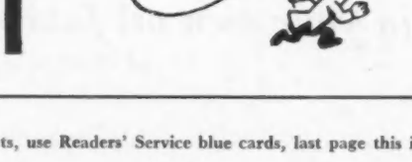

WHO'S MEETING WHERE

SEPT.	
5–11	Twentieth Annual Geological Congress, Mexico City.
7– 8	Association of Desk and Derrick Clubs of North America, Fifth Annual Meeting, New Orleans.
12–14	National Petroleum Association, Annual Meeting, Traymore Hotel, Atlantic City, N. J.
20–21	Annual Membership Meeting, Louisiana-Arkansas Division, Mid-Continent Oil and Gas Association, Roosevelt Hotel, New Orleans.
20–22	Oklahoma City Geological Society Field Conference, Guymon, Okla.
23–26	American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Statler-Hilton Hotel, Dallas, Texas.
26–28	Rocky Mountain Association of Geologists, Fall Field Trip, Southeastern Colorado, Denver.
30-Oct. 2	American Congress on Surveying and Mapping and American Society of Photogrammetry, Fall Convention and Co-Exhibit, Shirley-Savoy Hotel, Denver.
OCT.	
2– 3	Texas Mid-Continent Oil & Gas Association, 37th Annual Meeting, Rice Hotel, Houston, Texas.
7– 9	American Association of Oil Well Drilling Contractors, 16th Annual Meeting, Texas Hotel, Fort Worth, Texas.
14–17	AIME, Petroleum Branch Fall Meeting, Biltmore Hotel, Los Angeles
14–20	Oil Progress Week.
18–21	Permian Basin Oil Show, Ector County Coliseum and Fair Park area, Odessa, Texas.
22–24	Rocky Mountain Oil & Gas Association, Annual Convention, Cosmopolitan Hotel, Denver.
22–26	National Safety Congress and Exposition, Conrad Hilton, Congress, Morrison and La Salle Hotels, Chicago.
23–26	National Association of Corrosion Engineers, South Central Region, Gunter Hotel, San Antonio, Texas.
29-Nov. 1	Society of Exploration Geophysicists, National Convention, New Orleans.
31 to Nov. 2	Gulf Coast Association of Geological Societies, 6th Annual Convention, Plaza Hotel, San Antonio, Texas.
NOV.	
8– 9	American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Economic Paleontologists and Mineralogists, Pacific Section, Ambassador Hotel, Los Angeles.
12–15	API, 36th Annual Meeting, Conrad Hilton and Palmer House Hotels Chicago.
19–20	AIME, North Texas Section, Symposium on Secondary Recovery, Municipal Auditorium, Wichita Falls, Texas.
25–30	American Society of Mechanical Engineers, Statler Hotel, New York.
29-Dec. 15	Indian Industries Fair, New Delhi.
30-Dec. 1	Interstate Oil Compact Commission, Annual Meeting, Wichita, Kansas.
1957	
APRIL	
6–11	Petroleum Equipment Suppliers Association, Palm Springs, Calif.

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Jonathan Club, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary, New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

Looking Ahead . . .

. . . **Oil companies face higher costs** following settlement of the steel strike. Oil country casing and tubing were increased in price by about $14 per ton. That was more than the average steel price increase of $8.50 per ton. Oil companies also will have to pay higher prices for numerous other products made of steel.

•

. . . **To cover higher costs,** oil companies probably will have to depend mainly on further increases in volume of business. Fortunately, sales can be increased, with benefit of the continuing expansion of petroleum consumption.

•

. . . **The oil industry probably could not recover current increases in costs** by passing them on to oil consumers. Increases in prices of crude oil and products do not look feasible. Crude oil and gasoline are in ample if not excessive supply. In fact, prices of high gravity crudes lately have been cut around 7 cents a barrel in West Central Texas, the Texas Panhandle, and some Oklahoma fields. There is now a threat that crude price cutting may spread to other Mid-Continent areas.

•

. . . **Producing companies throughout the country** have been confronted with dwindling supplies of casing, during and following the steel strike. Casing and tubing were generally scarce even before the strike. The loss of over a month's production of pipe accentuated the shortage.

•

. . . **Smaller operators are being affected more than large companies** by the current steel shortage. The shortage therefore is being widely felt. Independents drill almost 80 percent of all U. S. wells. They generally do not have the funds required to carry large inventories of tubular goods. Many major companies have comparatively good supplies of steel goods. But as previously indicated, their drilling is only about 20 percent of the industry total. Furthermore, even the major companies, in some instances, are short of tubular goods, which are everywhere scarce.

•

. . . **Drilling contractors have felt the pinch of pipe supplies** in a slowing down of drilling jobs on development wells. There have been reports of canceling of development well jobs by operators in order to keep the casing for "must" exploratory wells—where lease obligations had to be met without delay. On the basis of these reports, it is indicated that the pipe shortage will retard this year's development drilling more than exploratory drilling.

•

. . . **Some Western Canadian crude now is finding a market** on the U. S. West Coast as far south as San Francisco. Starting in July, Standard Oil Company of California has programmed a 12,200 barrel-per-day import schedule. The crude is being brought from Vancouver down to the company's Richmond refinery in the San Francisco area. Under present plans, the company intends to maintain this schedule through November of this year.

•

. . . **These California imports of Canadian crude** are made possible by the fact that Standard of California is shipping fuel oil to the Pacific Northwest, and on return trips is bringing back Canadian crude. Heretofore, it generally has not been economically feasible for Canadian crude to go as far south as San Francisco. High tanker rates and the prevailing prices of oil generally limited Canadian crude movements only as far south as the Seattle area. Canadian crude goes there to refineries of Shell Oil Company and General Petroleum Corporation, subsidiary of Socony Mobil Oil Company.

•

. . . **Synthetic fuel made from oil shale or coal** may become competitive with petroleum in the U. S. before many years elapse. This prediction was included in the final report of the Interior Department on the government's research program on synthetic liquid fuels. The department commented that new petroleum reserves were being discovered only with increased effort and expense.

•

. . . **"The present price differential in favor of natural petroleum products,** as compared with synthetic products," stated the Interior Department, "is expected to become less as a result of the relatively diminishing natural supply and of continuing research that will increase efficiency in production and lower the final cost of synthetic fuels."

	SERVICE	WHAT IT CONTAINS	FOR THESE WELLS	ADDITIONAL DESCRIPTION
OIL BASE	**PETROJEL**	Thickened crude, kerosene, or diesel fuel. Sand.	Oil or gas.	Primarily for use in formations with low acid solubility. Friction loss is lower than that of refined frac oils. Controlled fluid loss. Can be used at temperatures up to 200°F.
OIL BASE	**PETROFRAC**	Thickened crude, diesel fuel, or distillate. Sand.	Oil or gas.	Especially useful for treating wells with low bottomhole pressure. Use of high-gravity crudes makes it possible to fracture gas wells where heavier oil mixtures might be undesirable.
OIL BASE	**SANDFRAC**	Crude or refined oil. Sand.	Oil or gas.	For all types of formations—particularly suited to those of low acid solubility. Low fluid loss. Demulsifying agents may be added.
ACID BASE	**ACID PETROFRAC**	Acid-in-oil emulsion—using crude, kerosene, distillate, or diesel fuel. Acid is 90-95% of total volume. Sand.	Oil or gas.	Primarily for use in acid-soluble formations. Silicate control; retarded acid action; controlled fluid loss. Acid concentration can be varied from 1 to 15%.
ACID BASE	**FRAC ACID**	Thickened acid. Sand.	Oil, gas or water.	Primarily for use in acid-soluble formations where fracturing and acidizing are both desirable.
ACID BASE	**STRATAFRAC**	Acid-kerosene emulsion. Sand.	Oil or gas.	Primarily for use in acid-soluble formations. Acid concentration can be varied.
WATER BASE	**RIVERFRAC**	Fresh or salt water. With or without sand.	Oil, gas; water injection, disposal and supply.	For all types of formations. The use of water practically eliminates the fire hazard.
WATER BASE	**WATERFRAC**	Thickened fresh or salt water. Sand.	Oil, gas; water injection, disposal or supply.	Primarily for use in formations in which the use of oil-base treating materials might be undesirable or detrimental.

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Widest variety of fracturing services and materials in the oil industry

F.L.A.—Added to the treating fluid, this easy-to-use powder substantially lowers the fluid-loss characteristics.

FIXAFRAC—A Dowell service that temporarily seals initial fractures, or permeability already present, to permit a concentrated fracturing or acidizing attack on other sections of the pay formation.

MUD ACID—A Dowell acid that dissolves clay minerals and destroys the swelling properties of bentonitic material. As a spearhead, it increases treating effectiveness by cleaning formation face.

ACID INHIBITORS—Dowell acid inhibitors provide maximum protection to metal up to 350°F., yet allow full treatment effectiveness.

ADDITION AGENTS — Dowell engineers use a wide variety of addition agents in tailoring fracturing treatments to fit your wells. These agents control swelling of clay minerals and other silicates, lower surface tension, minimize formation of emulsions, speed up or retard reaction rate of acids with dolomites, etc.

HIGH INJECTION RATE—Special-built Dowell equipment provides better distribution of sand and treating fluid. More of pay zone is treated. Results have shown more production and slower decline.

MODERN EQUIPMENT — Typical of the Dowell look to the future is the development of the rugged Allison-powered pumping unit with its 1500-h.p. aircraft engine. The Allison, the new 60-barrel-per minute blender and the revolutionary Remote Control Panel bring new power and safety to fracturing and acidizing.

In the field, in treatment after treatment, this rugged Dowell pumper has proved its dependablity in oil and gas wells.

For more information, or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write to Dowell Incorporated, Tulsa 1, Oklahoma, Dept. I-13.

services for the oil industry **DOWELL**

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

New Ownership of American Business

Blistering attacks will be made on big business during the next several months, as the two U. S. national political parties campaign for the presidency. This raises the question of just who is big business in the U. S.

Big business is not what it was a few years ago. A tremendous change has taken place. American business has a new ownership. Not too long ago stocks in big U. S. corporations were held mostly by a pretty small number of large wealthy investors. However, this is no longer true.

The number of stockholders in U. S. business firms has increased rapidly in recent years, and gives signs of continuing to grow at expanded rates in the future. Business corporations today are owned by a vast number of individuals.

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The American people own the country's business today. According to a New York Stock Exchange survey, stock in the 4600-odd U. S. corporations with more than 300 stockholders is owned by 8,630,000 different individual shareholders. This is 33 percent more than the 6,490,000 that owned stock at the end of 1952. This is after eliminating duplication because of individuals owning stock in more than one corporation.

This means that one out of every 12 U. S. adults owns some stock in at least one publicly owned company. Four years ago only 1 out of 16 adults owned any stock.

In addition to the above, an estimated 1,400,000 persons own stocks in closely held corporations only. Hence, total number of business stockholders in the U. S. exceeds 10 million.

Owning stock in U. S. business firms no longer is a privilege reserved for the wealthy. Nearly two-thirds of the current shareowners live in households earning under $7,500 annually, one-third earn less than $5,000. Nearly 3 percent of all families earning less than $3,000 own some stock, while 28.6 percent of the families $7,500 and up own stock.

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Even the biggest companies are owned by a large and increasing number of people. General Motors, world's largest manufacturing concern, is a typical example. Two-thirds of General Motors common stock is owned by 541,000 people, about 90,000 of whom are employed by the company. Fifteen large stockholders own the remaining one-third, including 23 percent owned by Du Pont & Company.

Standard Oil Company (New Jersey), largest of the oil companies, has 324,000 shareholders. Five years ago the company's stock was owned by only 222,000 people. Gulf Oil Corporation now has 73,705 shareholders compared with 32,336 in 1950. Phillips Petroleum Company's 90,246 stockholders today contrasts with but 53,671 in 1950.

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A big factor in the widening of stock ownership is the basic economic prosperity of the country, particularly the improvement in the low income group. However, another big factor—and a growing one—is the widespread adoption of employe stock purchase plans. Seventy-five firms on the New York Stock Exchange alone have started employe stock purchase plans since 1947.

General Motors commenced a savings-stock plan last October. Already 90 percent of more than 100,000 eligible salaried workers have invested $32 million in it, with the company contributing another $16 million. During the last six months, 32,000 salaried Ford Motor employes have invested $7½ million in the company's stock, with the company putting up an additional $3¾ million.

American Telephone and Telegraph has 250,000 employe-stockholders. General Electric has 50,000 employe-stockholders. Socony-Mobil, which started its saving plan only five years ago, now has nearly 38,000 employe-stockholders, 88 percent of its total employes. Eleven thousand of Pure Oil Company's employes are stockholders.

A great many companies, including most of the large oil companies, have inaugurated employe stock purchase plans during recent years. The ownership of American business is to continue to become more widespread, and more and more into the hands of the average American, particularly the company employe. A "people's capitalism for all" is rapidly developing in the U. S.

Warren L. Baker

Second Quarter Earnings Up 15.4% for 46 Oil Companies

• International and domestic companies show about same increase over last year.

• Net income of 46 companies for first half of year up 17.6%, reflecting better gain for first quarter.

By L. J. LOGAN
WORLD OIL Staff

EARNINGS OF the petroleum industry this year have run better than 15 percent above last year. They have been relatively better than for business as a whole.

For the second quarter of this year, 46 oil companies reported combined net income of $716,965,599. (See table herewith, compiled by WORLD OIL.) That was an increase of 15.4 percent over the amount they earned in the June quarter of last year.

Business in general earned only about the same amount in the second quarter of 1956 as in the like period of 1955. *The Wall Street Journal* of August 6, 1956, reported that 551 companies in all major industries earned $2,576,530,000 in the second quarter of 1956, a decrease of 0.8 percent from the June quarter of 1955. In that report, gains of 15 percent or more were shown by the following industries: petroleum, airlines, distillers, drug manufacturers, mining and metals, office equipment, railway equipment, and tools and machinery. Increases of less than 15 percent were shown by these groups: chemicals, big stores and mail orders, food products, iron and steel, printing and publishing, rubber and rubber goods, tobacco companies, utilities, and railroads. Less second quarter profit in 1956 than in 1955 was reported for the following lines: aircraft makers, automobile and equipment, building materials, electrical equipment, farm equipment, movies and movie theatres, radio and television and textiles.

The internationally operating and domestic oil companies showed practically the same increases in second quarter earnings—15.5 percent for the internationals and 15.4 percent for the domestic concerns.

Above-average increases of 25 percent or more in second quarter earnings were reported by Gulf Oil Corporation, Socony Mobil Oil Company, Ashland Oil & Refining Company, Chicago Corporation, Getty Oil Company, Imperial Oil Ltd., The Pure Oil Company, Seaboard Oil Company, Shell Oil Company, Signal Oil and Gas Company, Sinclair Oil Corporation, Standard Oil Company (Ohio), and Tidewater Oil Company. Oil companies showing decreases in second quarter earnings included: Bishop Oil Company, Louisiana Land & Exploration Company, Richfield Oil Corporation, Standard Oil Company of Kentucky, Sunray Mid-Continent Oil Company, Texas Pacific Coal & Oil Company, Union Oil Company of California, and Union Oil & Gas Corporation of Louisiana.

First Half of Year. For the first six months of this year, the increase in oil company earnings over last year was a little larger than for the second quarter. This reflected the relatively better gains in the first quarter. For 45 oil companies, first quarter earnings were 20.4 percent above last year. (WORLD OIL, June, 1956, Page 89.)

Combined net income of 46 oil companies for the first half of 1956 was $1,489,967,587. That was an increase of 17.6 percent over profits in the like period of 1955.

For the first half of this year, five international companies earned 18.7 percent more than in the initial half of last year. That was a slightly better performance than the gain of 16.0 percent for domestic companies.

In most instances, the above named companies that had better than average gains in earnings in the second quarter also showed above average increases for the first half of the year. Companies that showed decreases in earnings for the first half included Arkansas Fuel Oil Company, Quaker State Oil Refining Corporation, Richfield Oil Corporation, Texas Pacific Coal & Oil Company, and Union Oil Company of California.

Outlook for Latter Half. Oil industry earnings promise to continue good for the latter half of this year. They should continue well above 1955 results in coming months. This seems assured because of this year's record breaking demand for petroleum products and the prevailing stable prices of oils. The industry is doing a record volume of business at relatively good prices. These advantages are fairly well compensating for this year's increases in costs of operation, with wages and prices of materials higher.

In its recently issued monthly review of the petroleum situation, the Chase Manhattan Bank, New York, offered estimates of petroleum demand. For the first seven months of this year, over-all demand for petroleum has been 6.0 percent greater than in the like period last year, according to the report. In July the total demand was 5.6 percent above a year ago. Movement of gasoline, the industry's principal product, in July was up 6.3 percent over a year earlier. Distillate demand continued strong. But residual, reflecting the steel strike, was weak.

Prices of gasoline and other refined products have held fairly steady in spite of larger gasoline stocks than are needed. In some sections of the country product prices have been

somewhat better this year than last year.

Prices of Pennsylvania grade crude oil have been increased several times this year. That crude is in good demand for manufacture of high quality lubricants. The higher crude prices have aided Appalachian producers but have narrowed profit margins of refiners of that crude.

There have been recent small increases also in prices of good lubricant stock crudes in Southwest Texas.

On the other hand, prices of high gravity crudes have been reduced moderately in recent weeks in West Central Texas, the Texas Panhandle, and certain Oklahoma fields. Those reductions reflected excessive production of the gasoline-bearing crudes involved and the current over-supplies of gasoline.

Middle East Situation. The earnings outlook for the international companies has been clouded somewhat by the Suez Canal seizure and the resultant threat to the Middle East oil trade. However, the Middle East operations are only a part of the far-flung activities of the big international concerns. And even the Suez situation so far has not appreciably affected their operations. If necessary, the international companies could to some extent substitute Western Hemisphere oils for Middle East oils in supplying their customers.

Domestic companies probably would be affected favorably, rather than unfavorably, from an earning standpoint, by interruption of Suez Canal oil movement. For such a situation might call for a stepping up of U. S. oil production and refining.

Oil Company Earnings for First Half of 1956

COMPANY	SECOND QUARTER						FIRST HALF					
	TOTAL DOLLARS			DOLLARS PER SHARE			TOTAL DOLLARS			DOLLARS PER SHARE		
	1955	1956	% Diff.	1955	1956	% Diff.	1955	1956	% Diff.	1955	1956	% Diff.
INTERNATIONAL COMPANIES												
Gulf Oil Corporation	46,551,000	68,753,000	+ 47.7	1.66	2.44	+ 47.0	91,871,000	138,072,000	+ 50.3	3.27	4.91	+ 50.2
Socony Mobil Oil Company	48,000,000	62,000,000	+ 29.2	*1.09	*1.41	+ 29.3	100,000,000	124,000,000	+ 24.0	*2.28	2.83	+ 24.1
Standard Oil Company of California	56,212,191	60,556,309	+ 7.7	*.89	.96	+ 7.9	109,342,748	122,050,274	+ 11.6	*1.73	1.93	+ 11.6
Standard Oil Company (New Jersey)	167,000,000	187,000,000	+ 12.0	*.85	.95	+ 11.8	344,000,000	392,000,000	+ 13.9	*1.75	2.00	+ 14.3
The Texas Company	68,812,831	68,130,366	+ 1.0	*1.26	1.25	— 0.8	124,834,043	138,088,709	+ 10.6	*2.28	2.52	+ 10.5
Total 5 Companies	386,576,022	446,439,675	+ 15.5	....	....	.....	770,047,791	914,210,983	+ 18.7	....	....	.....
OTHER COMPANIES												
Amerada Petroleum Corporation	5,796,936	5,929,028	+ 2.3	*.92	.94	+ 2.2	12,196,634	13,551,976	+ 11.1	*1.93	2.15	+ 11.4
Arkansas Fuel Oil Company	1,673,412	1,827,197	+ 9.2	.44	.48	+ 9.1	3,831,153	3,733,873	— 2.5	1.01	.98	— 3.0
Ashland Oil & Refining Company	2,137,867	3,103,592	+ 45.2	.32	.48	+ 50.0	5,162,452	6,754,517	+ 30.8	.80	1.07	+ 33.7
Atlantic Refining Company	9,089,000	9,973,000	+ 9.7	.97	1.08	+ 11.3	18,882,687	22,148,907	+ 17.3	2.03	2.40	+ 18.2
Bishop Oil Company	89,521	80,888	— 9.7	.17	.15	— 11.8	158,283	199,640	+ 26.1	.30	.37	+ 23.3
Chicago Corporation	1,533,013	2,195,000	+ 43.2	.38	.53	+ 39.5	3,603,013	4,541,000	+ 26.0	.86	1.09	+ 26.7
Cities Service Company	10,199,000	12,225,000	+ 19.9	1.03	1.21	+ 17.5	25,349,000	30,405,000	+ 19.9	2.56	3.01	+ 17.6
Colorado Oil & Gas Company	228,910	622,847	+172.1	.08	.16	+100.0	634,195	1,155,892	+ 82.3	.12	.29	+ 41.7
*Creole Petroleum Corporation	68,849,000	75,212,000	+ 9.2	.89	.96	+ 7.9	144,793,000	158,655,000	+ 9.6	1.87	2.04	+ 9.1
Continental Oil Company	10,030,000	11,755,000	+ 17.2	1.02	1.21	+ 17.6	22,172,000	25,549,000	+ 15.2	2.27	2.62	+ 15.4
Getty Oil Company	942,098	1,386,459	+ 47.1	*.16	.24	+ 50.0	2,175,842	3,719,669	+ 71.0	*.38	.64	+ 68.4
Honolulu Oil Corporation	2,992,733	3,112,341	+ 4.0	.80	.83	+ 3.8	6,194,551	6,861,477	+ 10.8	1.65	1.83	+ 10.9
*Humble Oil & Refining Company	42,534,000	43,060,500	+ 1.2	1.19	1.20	+ 0.8	88,284,000	92,360,500	+ 4.6	2.46	2.58	+ 4.9
*Imperial Oil, Ltd.	11,460,604	14,523,624	+ 26.7	.38	.48	+ 26.3	24,353,477	33,735,194	+ 38.5	.82	1.12	+ 36.6
*International Petroleum Co., Ltd.	7,600,000	9,200,000	+ 21.1	.52	.63	+ 21.1	16,100,000	18,500,000	+ 14.9	1.11	1.27	+ 14.4
Louisiana Land & Exploration Co.	3,557,866	3,454,615	— 2.9	.40	.39	— 2.5	6,933,002	7,059,786	+ 1.8	*.77	.79	+ 2.6
Maracaibo Oil Exploration Corp.	77,735	133,732	+ 72.0	.16	.27	+ 68.8	181,308	278,183	+ 53.4	.37	.56	+ 51.4
Mississippi River Fuel Corporation	1,671,564	1,978,386	+ 18.4	.49	.56	+ 14.2	3,323,827	3,807,726	+ 14.6	.98	1.10	+ 12.2
Ohio Oil Company	9,171,757	9,504,192	+ 3.6	.70	.72	+ 2.9	19,550,571	21,275,528	+ 8.8	1.49	1.62	+ 8.7
Panhandle Oil Corporation	155,301	258,715	+ 66.6	.07	.11	+ 57.1	366,019	545,863	+ 49.1	.15	.23	+ 53.3
Phillips Petroleum Company	20,465,512	23,233,481	+ 13.5	*.67	.68	+ 1.5	42,575,770	51,565,719	+ 21.1	*1.40	1.50	+ 7.1
Plymouth Oil Company	1,690,947	1,973,647	+ 16.7	.70	.81	+ 15.7	3,894,991	4,256,678	+ 9.3	1.61	1.75	+ 8.7
Pure Oil Company	6,652,000	8,642,000	+ 29.9	*.78	1.01	+ 29.5	16,081,000	17,826,000	+ 10.9	*1.88	2.08	+ 10.6
Quaker State Oil Refining Corporation	605,923	667,139	+ 10.1	.73	.81	+ 10.9	1,208,095	1,192,820	— 1.3	1.46	1.45	— 0.7
Richfield Oil Corporation	7,494,258	7,020,016	— 6.3	1.87	1.76	— 5.9	14,635,379	14,531,575	— 0.7	3.66	3.63	— 0.8
Seaboard Oil Company	1,692,581	2,311,665	+ 36.6	.46	.63	+ 36.9	4,048,754	4,974,575	+ 22.9	1.10	1.36	+ 23.6
Shell Oil Company	25,912,492	34,430,552	+ 32.9	.94	1.25	+ 32.9	54,497,284	69,440,912	+ 27.4	1.98	2.52	+ 27.3
Signal Oil & Gas Company	1,437,474	2,125,255	+ 47.8	.37	.54	+ 45.9	4,080,243	4,568,462	+ 12.0	1.04	1.17	+ 12.5
Sinclair Oil Corporation	16,593,249	20,858,150	+ 25.7	*1.14	1.44	+ 26.3	37,801,184	45,103,719	+ 19.3	*2.60	3.10	+ 19.2
Skelly Oil Company	7,125,270	7,507,050	+ 5.4	1.24	1.30	+ 4.8	14,823,411	15,540,112	+ 4.8	2.57	2.70	+ 5.1
Southern Production Company	1,009,616	1,058,148	+ 4.8	.58	.61	+ 5.2	2,239,179	2,334,855	+ 4.3	1.30	1.34	+ 3.1
Standard Oil Company (Indiana)	30,013,917	34,525,645	+ 15.0	*.89	1.02	+ 14.6	64,964,743	75,903,508	+ 16.8	*1.92	2.24	+ 16.7
Standard Oil Company (Kentucky)	3,273,000	3,245,000	— 0.8	1.26	1.25	— 0.8	6,147,000	6,250,000	+ 1.7	2.36	2.40	+ 1.7
Standard Oil Co. (Ohio)	4,093,166	6,933,312	+ 69.4	*.85	1.44	+ 69.4	10,173,009	13,450,544	+ 32.2	*2.11	2.79	+ 32.2
Sun Oil Company	12,685,228	12,883,320	+ 1.6	*1.25	1.27	+ 1.6	24,407,336	25,138,552	+ 3.0	*2.41	2.48	+ 2.9
Sunray Mid-Continent Oil Company	8,944,417	8,912,545	— 0.4	*.54	.54	.....	17,444,417	20,297,576	+ 16.4	*1.06	1.23	+ 16.0
Texas Gulf Producing Company	1,212,076	1,395,507	+ 15.1	*.33	.38	+ 15.2	3,067,000	3,193,000	+ 4.1	.84	.87	+ 3.6
Texas Pacific Coal & Oil Company	2,097,919	1,711,233	— 18.4	*.58	.48	— 17.3	4,121,411	3,766,149	— 8.6	*1.15	1.05	— 8.7
‡Tidewater Associated Oil Company	9,939,000	12,562,000	+ 26.4	.86	1.04	+ 20.9	18,022,000	21,599,000	+ 19.8	1.44	1.67	+ 16.0
Union Oil Company of California	9,202,097	6,587,926	— 28.4	*1.19	.86	— 27.7	16,308,664	13,618,151	— 16.5	*2.09	1.77	— 15.3
Union Oil & Gas Corporation of La.	1,040,383	756,832	— 27.3	.57	.42	— 26.3	1,394,314	1,995,068	+ 43.1	*.77	1.10	+ 42.9
Universal Consolidated Oil Company	505,661	855,745	+ 69.2	.53	.89	+ 67.9	1,007,777	1,754,032	+ 74.0	1.05	1.83	+ 74.3
Venezuelan Petroleum Company	852,647	2,085,385	+144.6	.21	.52	+147.6	1,930,682	4,361,715	+225.9	.48	1.09	+227.1
Wilcox Oil Company	207,112	241,867	+ 16.8	.73	.85	+ 16.4	430,583	541,586	+ 25.8	1.53	1.90	+ 24.2
‡Woodley Petroleum Company	391,041	462,512	+ 18.3	.51	.60	+ 17.6	484,741	964,259	+ 98.9	.63	1.26	+200.0
† Total 41 Companies	234,483,699	270,525,924	+ 15.4	....	....	.....	496,503,504	575,756,604	+ 16.0	....	....	.....
* Total 46 Companies	621,059,721	716,965,599	+ 15.4	....	....	.....	1,266,551,295	1,489,967,587	+ 17.6	....	....	.....

* Based on number of shares outstanding, June 30, 1956.
† Creole, Humble, Imperial Oil, and International Petroleum are excluded from totals, being included as subsidiaries of Standard Oil Company (N.J.).
‡ Data per share are for common stock outstanding in period involved and exclude earnings used for preferred stock dividends.

Direct Mail and Electronic Machines Replace Land Men in Unitization

OBJECTIVE—

Rapid ratification of large unitization agreement through use of direct mail and electronic machine methods.

CONCLUSION—

Direct mail is a marked improvement over the traditional procedure of sending land men to contact royalty owners.

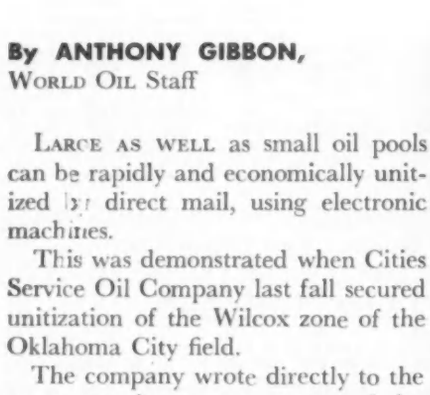
By ANTHONY GIBBON,
WORLD OIL Staff

LARGE AS WELL as small oil pools can be rapidly and economically unitized by direct mail, using electronic machines.

This was demonstrated when Cities Service Oil Company last fall secured unitization of the Wilcox zone of the Oklahoma City field.

The company wrote directly to the many royalty owners concerned, instead of following the conventional method of contacting them personally. The direct-mail campaign saved considerable money and time, and brought in thousands of acceptances for the plan.

Smaller units had been ratified by



PLANNING direct mail move: left to right, Bob Clark, M. S. Douglass and Don Wilson, of Cities Service Oil Company's land-lease department.

MECHANICAL "brains" of electronic machines solved complicated problem of figuring the percent of royalty owners participating and the number of signatures needed for unitization.

INFORMATION-filled cards were fed through giant machines which sorted, tabulated and calculated the information, then printed the findings in a fraction of the time required by hand calculation processes.

RAPIDLY-moving keys printed in one movement an entire row of information, making six copies at a time. Cut into page-sized sheets and exhibited to Oklahoma Corporation Commission, the plan won approval of commission.

mail before. But none as large as this one.

One of the most difficult problems in unitizing an oil field for repressuring purposes is to obtain the ratification of the royalty owners. In a large project this means contacting thousands of owners scattered all over the world. The job can take months and even years, and the cost can be enormous.

Unitization by mail of a unit the size of the Wilcox zone of the Oklahoma City field was unheard of in oil industry circles. But infinitely detailed plans and an experimental shortcut with electronic machines pushed the job through for Cities Service in greatly less time than by standard methods.

Cities Service engineers believe an additional 10 million barrels of oil can be recovered from the Wilcox in the Oklahoma City field by waterflooding. But the first hurdle was to obtain royalty-owner ratification of such a project.

Sale and resale of royalty and property in the field resulted in the division and sub-division of royalty ownership into such minute holdings that the 2154 acres comprising the unit were owned by approximately 3500 persons scattered all over the world.

Confronted with this problem the big question was: "What's the best method of unitizing? By landman contact as is accepted practice? By other means?" Time and cost were factors in the decision.

Then it was that the Secondary Recovery Section of Cities Service's Land-Lease Department decided on the procedure of using the mails.

The standard, tried and true method of obtaining ratification was to have a landman make personal calls on each of the 3500 owners. Past experience in such operations indicated that more than one call per owner would be necessary. This procedure would push time and cost consumption far above set limits.

Not only was the ratify-by-mail method cheaper, but, with careful planning, it could be accomplished in the required time without additional personnel.

Planning got under way early in the fall of 1954. While still in the rough the plan shifted into action by calling for a business machine firm to do the numerous mathematical computations. Accounting and similar type work are the jobs usually undertaken by electronic machines, and operators were inexperienced in the type of work desired by Cities Service, which necessitated several "trial runs."

While Cities Service is the larger owner in the unit and is also the operator, the joint owners, Phillips Petroleum Company, Sinclair Oil and Gas Company, and Continental Oil Company pooled their own royalty owner cards to cut costs. The perforated cards were fed into a machine which alphabetized, calculated and printed six copies of the needed information. This far surpassed hand calculation in speed and accuracy.

Meanwhile, easily understood letters and "common language" booklets were being written. The letter introduced the project to the royalty owner and the booklet factually outlined the plan, purpose and prospect in water flooding the Wilcox zone. Cities Service's Stenographic Department printed the thousands of copies of material.

Detail work was almost limitless, and centered around assembling booklets, addressing and stuffing envelopes for mailing. Well-laid plans plus efficient operation brought speedy results.

In order to distribute the load, each of the four companies took a quantity of the printed material and, on a predetermined date, simultaneously mailed the information to their royalty owners. This touched off the six months period during which the needed royalty owner ratifications must be obtained.

Then the first large-scale ratify-by-mail unitization program in the oil industry paid off.

Surprisingly, in about six weeks, the required ratification of 63 percent had been signed and returned. Ultimately, a total of 75.12 percent of the zone's acreage was ratified for waterflood by royalty owners—insuring a wide margin of owner approval.

The signed forms were photo copied and, along with the originals, were arranged in alphabetical order and bound into book form. The 20-volume, 30-pound stack of ratifications and computations were submitted to the Oklahoma Corporation Commission, which then granted its approval to water-flood the Wilcox zone in the Oklahoma City field. **—The End**

Suez Dispute—A Case of Double Jeopardy

The economics of both the West and Middle East are at stake in the Arab dispute. As in Iran, neither side can win.

By DON E. LAMBERT
WORLD OIL Staff

THE VIOLENT eruption of Arab nationalism poses a serious threat to the Free World. On the surface it would appear that Nasser has the West—particularly Europe—over an economic oil barrel.

At any moment the Suez crisis could send a wave of Egyptian-inspired emotional nationalism surging through the Arab oil producing countries with disastrous results. One possible reaction could be an Arab demand for a greater percentage of profit from oil concessions, thus discouraging further Western investment in Middle East Oil. The possibility also exists that the Suez Canal and Persian Gulf oil fields might become the sacrificial goats of nationalistic pride.

In any event, there is one consoling factor midst the Suez uproar: The economic oil barrel has two sides. On one side is the perilous position of Europe's economy and Western investments. On the other is the equally precarious position of the Middle East's economic future.

Effect On Free World Economy

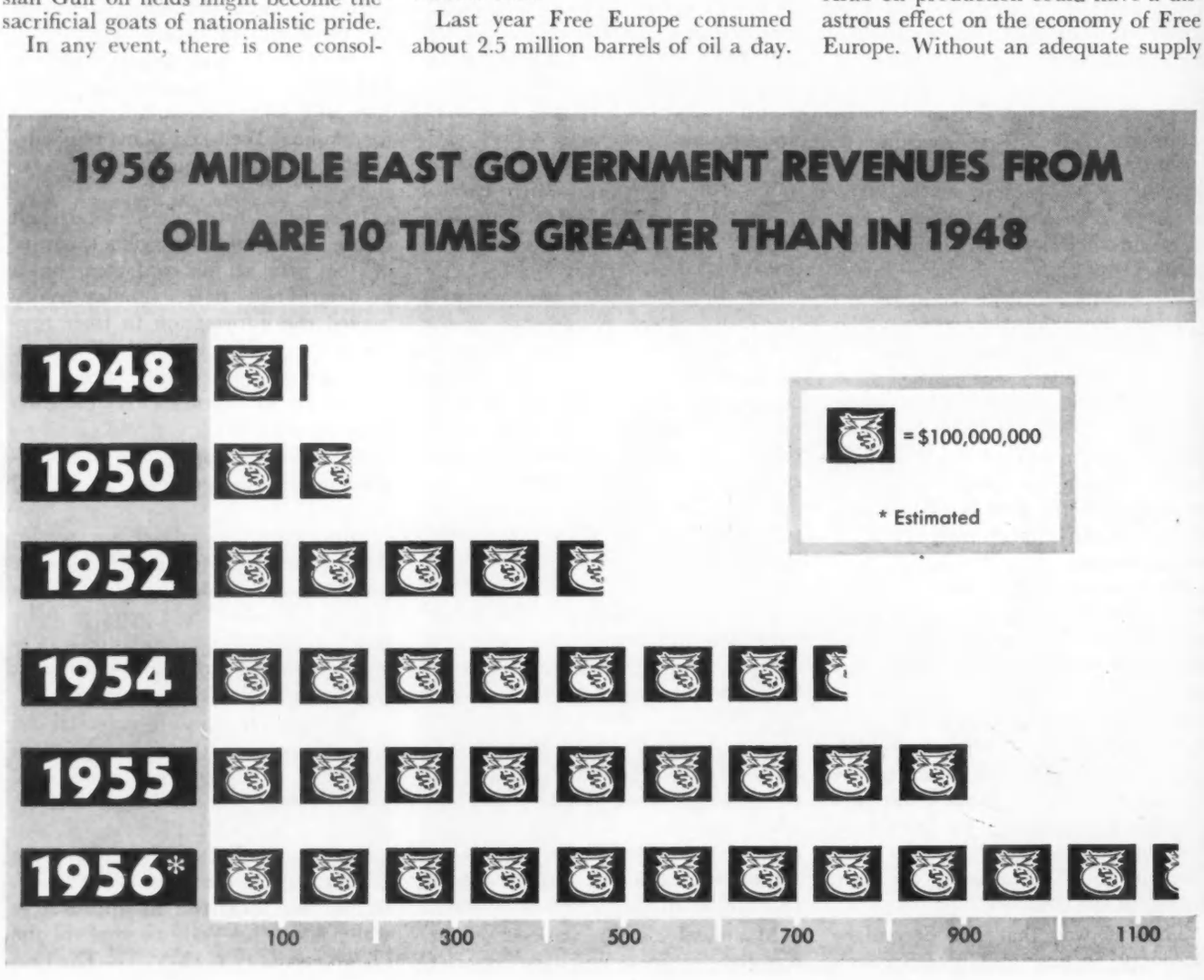
Europe. The Free World's bulwark against Communism—Western Europe—cannot begin to supply its oil needs. Domestic production meets less than 10 percent of the demand. The balance is imported—and 90 percent of those imports come from the Middle East.

Last year Free Europe consumed about 2.5 million barrels of oil a day. United Kingdom, the biggest oil consumer among the European countries, imported 413,000 barrels of Middle East oil a day via the Suez Canal, 70 percent of its oil supplies.

The second largest consumer, France, received 246,000 barrels of Middle East oil a day through Suez, 60 percent of its requirements. Sixty percent of Italy's oil needs also comes through the canal.

Furthermore, it is estimated that Free Europe has 15 days supply of oil on hand—at the most.

From these statistics it appears that a shutdown of the Suez and/or Arab oil production could have a disastrous effect on the economy of Free Europe. Without an adequate supply



of energy the economy of *any* country would be seriously retarded.

Western Investments. Since World War II, the Western nations have invested over $2.5 billion in Middle East oil.

Last year, U. S. oil companies represented 58.4 percent of all the investments in the Persian Gulf—Great Britain, 28.4 percent—British-Dutch, 7 percent—French, 5.3 percent—other countries, 0.9 percent.

U. S. oil companies alone had over $1.5 billion invested in the Middle East at the end of 1955—controlling two-thirds of that area's crude oil reserves.

Many of these firms represent the largest corporations in America. Should Middle East profits be cut off, the U. S. economy would feel its effects. The same impact would be felt in other countries with large investments in that area.

Need for Middle East Reserves. Perhaps even more important than Free Europe and Western investments is the realization that outside of the Middle East the Free World's reserves are dwindling in relation to sky rocketing demand. North America, South America, Western Europe, Far East and Africa combined account for only 50 billion barrels of crude oil reserves, of which 34.2 billion barrels are located in the U. S. Projected consumption rates indicate the Free World will consume this volume during the next 8 years. Of course this is not taking into account the new reserves that will be found during this period. The U. S. has had a 12-year supply of reserves every year for the last 20 years.

On the other hand, during the last 10 years the Middle East has *increased* its reserves from 19 billion barrels or 38 percent of the Free World's supply at the end of 1945—to 133 billion barrels, or two-thirds of the total in mid-1956. Middle East production has risen from 696,000 barrels a day in 1946 to 3.2 million barrels a day last year.

Within the next 20 years the U. S. and other Western nations will join Europe in ever-growing dependence on Middle East Oil. Alternative energy sources (i.e., atomic energy) will not be available for common consumption at present day costs for at least 25 years.

Economic stakes in the Middle East are high for Europe—for the U. S.—for every country in the Free World. But the stakes are higher for the Middle East.

Effect On Middle East Economy

The oil companies of the West have brought a new source of income to the governments and people of the Middle East. Government income from oil operations have jumped from $100 million in 1948 to over $900 million in 1955—and total income is expected to pass the $1 billion mark in 1956.

Kuwait, Saudi Arabia, Iran, Iraq and Qatar have used these funds to expand local services, to build schools and hospitals, to carry out development projects and to encourage the investment of local and foreign capital in industrial expansion.

The increasing oil revenues have materially raised the standard of living of millions of people. In addition, the oil industry directly employs nearly 200,000 Arab nationals and allied industries provide the livelihood for many thousands more.

An excellent example is that of the Arabian American Oil Company (Aramco) which employs more than 13,000 Saudi-Arabs (65.6 percent of the total work force). The average salary is $1068 a year, compared with $50 for non-oil workers. This doesn't include the many fringe benefits, service awards, medical care, retirement benefits, etc. that are offered to Aramco employes.

The Arabs are also fully aware of the $13 billion-plus Free World investors have ear-marked for future Middle East oil development. This income alone could do much to raise the Arab nations' standard of living. Also to be given top consideration are the many millions of dollars in foreign aid and technical assistance being provided by the Western countries.

Add up all these factors and it would seem sheer folly for the oil producing Arab countries to follow Nasser's bait—particularly in light of Iran's tremendous losses after Mossedegh's pleas nationalized its oil industry.

It is hardly conceivable to Westerners that the Middle East would cut its economic throat to appease its nationalistic pride. Nevertheless, the eventuality of complete nationalization of the Suez and Arab oil fields will remain a big question mark in the minds of Western leaders—and investors—for some time to come.

Alternative Short of War

If Arab nationalization should occur, the first concern would be Europe's immediate need for 1.3 million barrels of oil a day from sources outside the continent.

The Western Hemisphere could supply Europe's requirements in an emergency. So states Chase Manhattan Bank in a recent report:

"It is believed that Venezuela can produce from 250,000 to 300,000 barrels of oil a day over the current rate . . . The U. S. probably has a potential of 750,000 barrels a day additional production.

"Together, Venezuela and the U. S. could contribute in the neighborhood of a million barrels a day more oil. But Western Hemisphere oil is dollar oil while much of that from the Middle East is sterling oil. Because of balance of payment problems, Europe may be reluctant to take as much oil as the West has to offer."

However, as Chase Manhattan points out, if the Suez should be closed to traffic, emergency action would be required. Cooperative effort would permit consideration of such factors as balance of payments, laid down costs of oil from alternate sources, availability of tankers, delivery time and urgency of need. These would all have a bearing on the relative amounts of oil moving around Good Hope and from the West.

Oil moving to Europe from Western sources would travel less than half as far as that from the Middle East via Good Hope. This factor, when related to the limited availability of tanker tonnage, would seem to indicate that the West will be called upon to supply a minimum of an amount in excess of half a million barrels a day.

If complete Arab nationalization should occur, it is possible for Europe to continue to receive oil. It will, however, be more costly oil. And it will be more costly for the Middle East countries, too, because the half a million or more barrels a day supplied by the West would represent lost production—and lost income—for the Middle East. —**The End**

Shale Oil Soon May Compete with Crude

Advanced methods promise to produce oil from shale at same cost that crude oil is being recovered in many U. S. fields.

Costs could be held down by volume throughput and continuous retorting operation.

By ANTHONY GIBBON
WORLD OIL Staff

OIL FROM SHALE soon may become competitive with crude oil. Engineers say that soon it will be possible to produce shale oil, or "kerogen," at the same cost that crude oil is being produced from many U. S. fields.

A competitive cost for the shale oil would be based on volume throughput and a continuous retorting operation. Methods involved have been developed by the U. S. Bureau of Mines.

Billions of barrels of oil are locked in Colorado's vast reserves of oil shales. The U. S. government has given the bureau the job of finding a way to produce this oil economically, and the bureau has been devoting continuous efforts to the assignment. The oil industry naturally has kept a close check on these efforts.

For the past few years the bureau has concentrated its work in the Rifle area of Colorado. A corps of experts has made considerable progress in developing methods of mining the shale and extracting the oil from it. As a result, the gap between a profitable and a non-profitable method of producing shale oil rapidly is being bridged.

The most significant recent development in the shale project of the Bureau of Mines, under the Synthetic Liquid Fuels Program, is the success achieved in extraction of kerogen or shale oil under a continuous process. Previous experiments, which first started in 1945, had been conducted in batch-type retorts. Data from the batch process were used to design the first continuous gravity-feed retort used at Rifle.

A bed of shale moving downward through the retort, between two parallel sets of louvers, was retorted by a stream of hot retort gas, flowing horizontally through the bed, entering at one set of louvers and leaving through the other. This was called the Gas-Flow process.

A cost-evaluation study showed that investment costs would be high for this process and that cost of producing liquid fuels from oil shale is influenced to a rather large degree by the magnitude of investment cost. Furthermore, heat economy of the Gas-Flow process is poor. Accordingly, efforts on retorting were diverted to development of a low-investment-cost, thermally efficient process.

From experience gained, a retort was designed as a multi-purpose unit, capable of several operating arrangements. Continued operations and modifications of the new unit finally led to the development of the Gas-Combustion process and operation of a 6-ton-a-day pilot plant. Over 300 pilot-plant tests were made during the investigation of this process.

In all these experiments shale was heated with hot combustion gases generated in the retort vessel. The same basic vessel was used for all but a few of the experimental runs. It was a vertical, refractory-lined, cylindrical retort, 12 feet high and 20 inches inside diameter. For flexibility it was divided into three flanged sections which could be interchanged or used for various modifications of the retort.

In all the modifications, the retorted shale was removed at the bottom of the retort by a turntable, which could be operated at varying speeds, to control the rate of shale flow through the retort. Chains attached to the bottom of the turntable carried the spent shale to an opening above a sealed container. Principal dimensions of the Gas-Combustion retort are shown in Figure 1.

In this process, part of the heat for retorting of the shale is generated by burning recycled product gas in a combustion zone within the descending shale bed in the retort. Additional heat is supplied by combustion of the carbonaceous residue remaining in the spent shale after the oil has been distilled. Air for combustion is admitted through an air distributor in the center of the bed at about the midpoint of the retort. Hot gas rising from the combustion zone heats countercurrently the descending raw shale and liberated shale oil by pyrolysis of the shale.

After passing through and exchanging heat with the incoming raw shale, oil is condensed as a fog or mist in the gas, which is withdrawn at the top of the retort. The cool gas is then piped to an oil-recovery system where the oil is separated from the gas in centrifugal separators or other types of mechanical or electrostatic separators. The hot, spent shale below the combustion zone is cooled by heat exchange with recycle gas, which is a portion of the effluent gas from the oil-recovery system.

Important desirable features of the process are:

1. The spent shale leaves the retort at a low temperature of less than 200° F.; heat is conserved, and handling and disposal of the spent shale is simplified.

2. Temperature of the exit gas and

entrained oil is not over 175° F. At this temperature the oil is in the form of a mist that can be separated almost completely by mechanical means without further cooling.

3. Owing to the high over-all efficiency of the retort, energy in excess of that required for the process is available. This excess energy, in the form of low heating value gas, is suitable for steam or power generation or other purposes.

4. No cooling water is needed either at the retort or in the oil-recovery system. This is a highly important point since most of the richer beds of shale in the U. S. lie in semi-arid or desert regions where water is scarce.

5. Yield of oil from the Gas-Combustion retort, under properly controlled conditions, is high, approximately 95 percent of the Fischer assay of the shale.

Operating problems of the process are:

1. Temperature of the combustion zone must be controlled within fairly narrow limits. If the temperature is too low, the fire may go out; if too high, the mineral constituents of the shale fuse, forming clinkers.

2. Refluxing usually occurs unless conditions are controlled properly. This results in excessive cracking of the oil and a consequent lower oil yield. It also may result in agglomeration of shale particles owing to the formation of pitch or coke in or somewhat above the retorting zone.

3. For the best operation, the combustion zone must be uniform across the retort. An uneven combustion zone invariably causes erratic operation and low oil yields. Such a condition may result from clinker formation or from refluxing.

4. Rich shales containing more than about 33 gallons of oil per ton tend to agglomerate and form coke in the retorting zone, which interferes with uniformity of shale and gas flows.

Most of the troubles listed can be surmounted by careful control of the shale-air ratio and the shale-recycle gas ratio. These ratios must be determined through experience for shales of different compositions. With average Colorado shale as mined, containing about 30 gallons of oil per ton, the pilot plant has been run continuously for weeks with only minor operating difficulties.

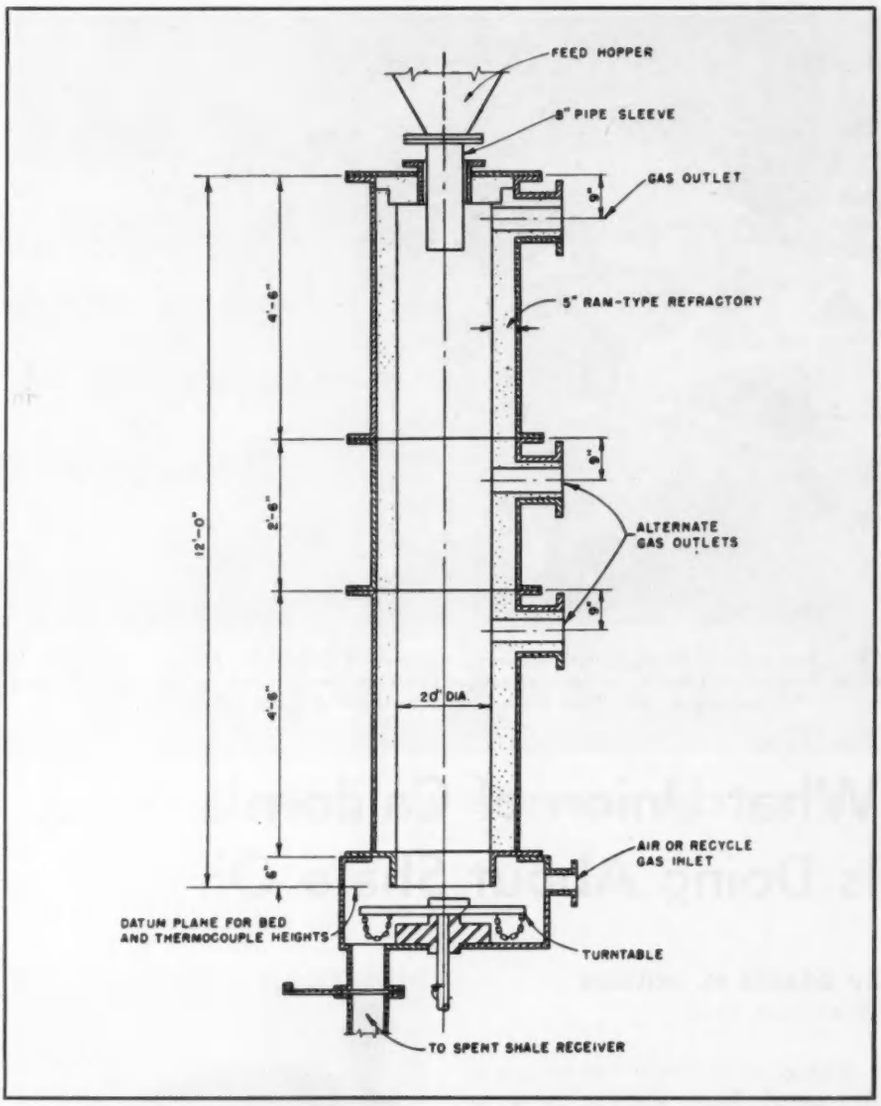


FIGURE 1—Basic oil shale retort.

Preliminary tests indicate that addition of a small amount of sodium chloride to the raw shale causes the formation of a more stable oil mist in the retort gas, owing to nucleation effects of the sublimed salt. When salt is added, operating conditions may be varied more widely without loss of oil by refluxing and cracking in the shale bed.

Many tests have been run without brine in which high oil yields were obtained. Data show that in most of these tests there was little or no refluxing and cracking of oil. From this it appears that addition of brine to the shale allows the retort to be operated under more varied conditions of shale, air, and recycle rates.

Without brine these flows must be held within narrow limits to prevent refluxing. Refluxing is undesirable not only because it reduces oil yield but also because it causes the shale to become coated with oil, resulting in the formation of agglomerated masses by the coking of the pitch remaining on the shale after redistillation of lighter portions of the oil.

Work is continuing on the process to improve yields, simplify operation, increase the throughput of shale, and to learn more about the chemical and physical phenomena encountered in the pyrolysis of oil shale by this process.

ACKNOWLEDGMENT

The above is excerpted from Bureau of Mines Report of Investigation 5154 by A. Matzick, J. R. Ruark and M. W. Putnam. The complete report can be obtained by writing U. S. Bureau of Mines, Pittsburgh, Penn.

One company has spent $1.5 million on shale oil research . . . See Next Page

This recent photograph shows work underway on Union of California's shale oil plant. This is where demonstration retort and auxiliary equipment will be located. Underground piping is being put in place here. Plant site is 11 miles northeast of Grand Valley, Colo.

What Union of California Is Doing About Shale Oil

By GILBERT M. WILSON
WORLD OIL Staff

SHALE OIL is destined to occupy an increasingly larger share in the oil industry's thinking—and expenditures—if recent developments of Union Oil Company of California are any measure.

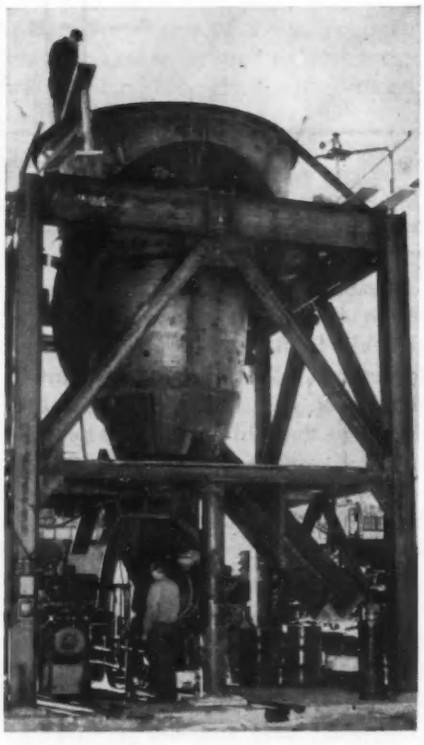
Early in 1955 that company earmarked $5 million for an intensive 2½-year oil shale research program, aimed at learning if marketable products from shale oil can be produced from its Colorado shale deposits at a cost competitive with those obtained from crude oil.

In a recent statement, the company made this comment: "We believe we have reached the point where the higher and increasing costs of discovery of new sources of crude oil are making more attractive the development of a shale oil industry."

The analysis started last year, the company now feels, is justified by four factors:

1. The Bureau of Mines, some years ago, demonstrated a method for low-cost, efficient mining of the shale.

2. During and immediately after World War II, Union Oil conceived and built two workable pilot models of retorts to extract the oil.



Union Oil Company's mock-up of their commercial shale retort. This pilot plant, constructed in the latter part of 1955, was used to study stresses and to obtain various design data. The commercial size unit, when built, will be from two to three times the size of the mock-up. The retort is designed to handle shale ranging in size up to 6 inches.

3. The company's Unifining process of reducing crude oil impurities, perfected during the last two years, has provided a new technique for converting virgin shale oil into good feed stock for conventional refineries.

4. Discovery costs of new domestic crude oil reserves recently have tended to approach or exceed the estimated cost of recovering oil from shale.

The company currently is constructing a full-scale, commercial size retort and all auxiliary facilities which is to be operated near Grand Valley, Colorado. Research work dealing with conversion of raw shale oil obtained from shale retorting to high quality marketable oil is being carried on simultaneously at the company's Research Center at Brea, California.

The company's oil shale properties near Grand Valley, Colorado, are very rich and reasonably accessible. It is conservatively estimated that the richest part of the shale deposits (Union's) contain approximately five billion barrels of recoverable oil—roughly eight times the company's current proved crude oil reserve.

The full scale commercial version of the Union Oil retort has been designed and is now being constructed by the general contractor, the Stearns-Roger Manufacturing Company of Denver. The auxiliary equipment for the retort has been purchased. A site for the plant has been cleared on the company's Parachute Creek property in Colorado, buildings have been erected and the rock crushers and conveyors are being installed. An all-weather road has been constructed from the retort site to the mining elevation in the shale cliffs. The mining contractor is currently preparing the mining face.

The research on methods of refining shale oil is well under way at the Brea (California) Research Center of the company. Special research equipment has been designed and built and extensive refining tests now are going on. The company reports that, generally speaking, after 14 months' work, they are on schedule, with both problems and progress occurring about as expected. Total expenditures thus far are slightly over $1,500,000.

—The End

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The Retirement Fad —Is It Good or Bad?

Bad, say two prominent psychologists. And here are their reasons.

By ALLAN J. FLEMING and C. A. D'ALONZO
E. I. du Pont de Nemours and Company
Wilmington, Delaware

THE RETIREMENT fad is here! More and more people are living to be 65 years of age, and more and more people 65 years of age are retiring.

Many healthy individuals are not waiting for 65, but are jumping aboard the bandwagon sooner. With this trend, a new era of civilization is upon us. Retirement motels, hotels, villages, and towns are springing everywhere. You can work your way through, or pay for it. You can wait on tables, or be waited upon.

Accompanying this swing is a deluge of pills to help you enjoy old age, mentally and physically, pills that make you sleepy, but not drowsy; food that will give you the feeling of satisfaction of having eaten a big meal, but which do not add calories; lotions to make your skin soft and younger looking but which are said not to cause dermatitis; cathartics which give you effective purging, but which are claimed to be non-irritating. "X" mixtures are available in toothpastes, hair tonics, gland creams, and geriatric pills. There are specially designed chairs that permit you to sit, lie, or stand, without any muscular effort on your part. Day-time television programs are here to entertain the infantile, puerile, or the senile.

Just in case you run a little short of change, you can raise mushrooms or chinchillas in your cellar, grow orchids in your kitchen, or bats in your belfry. If you are still having difficulty, you might want to consider moving to some other country where living is cheap, and it is possible to pay for one or two servants with your social security check.

We are trying to make retirement so attractive that an entire new philosophy has developed of it. Thus, one 20-year older took one look at the pension and retirement benefits of a large company and said, "Man, I can't wait." This is in line with the philosophy that old age begins at birth. We next expect some third dimensional therapeutic agent to appear which will speed the age process so that we can reach 65 years sooner.

Employment is now considered to be something one has to sweat through until the lovely years of retirement are reached. Booklets are available which tell you, in a few minutes, how to prepare for this wonderful reawakening. These inform you how to cultivate your thinking so that you will be prepared for the time when you no longer are required to think.

Forgotten in the retirement craze is the unretiring wife. For the first time she has good old "do it yourself" Albert hanging around the house twenty-four hours a day. If he has never done anything useful around the place during his active years, he will undoubtedly perform equally well during retirement. The meals, the shopping, the housecleaning go on as usual while Albert plans the political downfall of the other party, spills ashes on the carpet, operates the "Hi Fi" set at a 120 decibel level, and writes letters to the editor.

During the early thirties the joys of retirement were delightfully illustrated with pictures of a robust, healthy middle aged man sitting in a boat fishing as his less middle-aged wife pulled on the oars—and all this pleasure with a guaranteed monthly income of $50.

Today we are amazed to see pictures of the same couple, still youthful and robust, and still trying to catch a fish. However, two wars and 20 years of the New Deal has increased the need of the monthly income to $250.

One would suppose that by this time the husband would have become discouraged by the lack of fish, and the wife mighty tired of rowing—but alas, that's retirement for you!

The pleasure, mental fulfillment, and enjoyment, the accompanying satisfaction after a day's work, well-done, appears to be overlooked. We should realize that the happy, contented worker is likely to develop his skills, pleasures, attitudes, and family enjoyments, so that the process of preparation for retirement occurs slowly and deeply, over a life time, with gradual but firm physical, spiritual, and mental metamorphosis. More often these pleasures, or hobbies, will probably be related to the same skills and knowledge to which one has previously been employed, and particularly which one has enjoyed over a life time, rather than frustratingly performed over a life time just waiting for age 65.

One cannot talk of retirement without bringing up the related subject of hobbies, the next great national trend. The development of a hobby is thought by some to be paramount for the preparation of retirement.

Modern "authorities" seem to have lost track of the possibility that a man's work might be a hobby. The present trend is to view a man's position or job as something that is nerve-wracking, produces coronary thrombosis, breaks up families, and makes one feel quite miserable and always eager to escape. In other words, the present concept of a man's work all seems directed into the belief that all jobs are a short cut to the nearest insane asylum. When a person wishes for his working day to end so he can get to his hobby which he enjoys, then his life is mixed up and needs readjusting. That person had better start to make his hobby his vocation.

Webster defines a hobby as "an engrossing topic, plan, etc., to which one constantly reverts; also, an occupation or interest to which one gives his spare time." It is plain that even the definition admits that an occupation might possibly be a hobby, even though it does not permit you to do what you like full time. The idea of the vocational hobby seems lost in the modern trend. An engrossing topic or plan to which one often reverts might

also be identified with loafing. Might not loafing be a hobby for some? There is also a little flaw in the definition referring to spare time, because the playboy might have 24 hours spare time, whereas a working man might have very few hours spare time. We submit that the definition might be broadened to include an occupation, the interest to which one gives his full as well as his spare time, but which he enjoys. A hobby might be beneficial or detrimental, profitable or profitless. A happy vacation is a good example of a desirable hobby.

Too often the very people for whom hobbies are recommended, by professional as well as non-professional advisors, already have one which is not recognized as such. Drinking might be considered a hobby for some, and is a good example of one which might be desirable or undesirable. Overworking could be a hobby for others, but we are reaching the point where it is considered disrespectful to overwork.

We are not opposed to hobbies as such. Our disagreement is with the widely disseminated and generally accepted view that to be happy one requires a hobby. This concept is erroneous. A lot of happy workers do not require a hobby, and in retirement one need not be developed, often it is there. It may not be recognized or defined as a hobby, but its function is the same. Moreover, it is still possible for a person to enjoy his job sufficiently whether it be clerking or garbage collecting, so that he does not mentally require, for happiness, any other hobby.

One's job must be dull and incompatible if a day is wasted, waiting for it to end. Golf, matchbox collecting, and others are still not necessary for happiness. It is conceivable that a man can like his job, regardless of what it might be, to the extent that when his day's work is done, he contentedly looks back on the day with pride, and he views with happiness, not alarm, the next day. Moreover, it is again possible for one to be sufficiently content and engrossed with his work that he puts ten to fourteen hours a day in it. The poor soul is to be pitied who has to find something else after eight hours of work to create happiness for himself because he only has to face his dreary job again at 8 o'clock the next morning. Don't pity the plugger who takes his work home with him at night, or who works long hours into the night. Pity the man who, at 5 p.m., gets a sentence of freedom only until 8 a.m. the next morning.

There are those who believe that when a person to be pensioned does not have a hobby which is detectable as such, his chances of acquiring a beneficial one are slim. Hobbies might be like talent, you either have it or you "ain't" got it. If you have it, it is most likely something from which you might even be deriving your livelihood. Unrecognized hobbies are common.

The idea of older people looking for new hobbies does not impress us. Take the case of a physician, lawyer, or dentist who has spent the greatest part of his life training and acquiring more and more knowledge and skill in his profession, and is expected only to end up at 65 plus years of age and drop it all because some well wisher advises him to seek a hobby.

If he enjoyed his life work, retirement could mean tapering off, reducing the load, exploring some small particular phase of his vocation, which until now, time has not permitted, or perhaps a part-time teaching assignment. If this is not possible, it seems reasonable that he should have changed his profession years ago. To suggest to a competent craftsman at age 65 that he start collecting stamps is wasteful, and, in our opinion, poorly given advice. How much better that person would be to channel his training into some special field of his life's experience.

It is psychologically reasonable that, in retirement, and the so-called need to develop a hobby, one's chief concern is the fear of oncoming death itself. The hobby is just the sleight of hand to keep your mind off the fact that after 60, 70 arrives. And as one gets older, death gets closer.

Preparation for old age should be to teach against the fear of death. Death is not necessarily undesirable, prolonged, or painful. Religious training has seemed to fail utterly in the preparation for, and belief in, life hereafter. Remember the clergyman who, dying of cancer, said that death was a privilege and not a curse.

Life must be dull and drab, hobbies or no hobbies, for those who let each day arrive simply to bring them closer and closer to death. The man with the peaceful, contented mind, and a Christian attitude, without fear or thought of death, is the happy contented individual, with or without a hobby, and more often the one who lives the longest.

One cannot fear death without fearing life. And if you fear life, you are pathetic.

Our ideas of retirement, hobbies, life, and death need a complete rejuvenation. —**The End**

About the Authors

Fleming

D'Alonzo

ALLAN J. FLEMING, medical director for Du Pont, has been engaged in industrial medicine since 1935. A native of Canada and a graduate of the medical school at Montreal's McGill University, he started as a plant physician with Canadian Industries, Ltd., in Quebec, and later joined Du Pont as a toxicologist in its laboratory for toxicology and industrial medicine. The laboratory is devoted to research on potential hazards associated with Du Pont processes and products. In 1941, he was made assistant director of the laboratory, and in 1948 was appointed assistant director of the Medical division. He became director in 1954.

C. A. D'ALONZO, assistant medical director for Du Pont Company, has been engaged in the company's preventative-medicine program for employes since 1939. He joined Du Pont that year as supervisor of the medical unit at the experimental station near Wilmington, Del. Dr. D'Alonzo is a graduate of the University of Virginia, where he also completed his medical education. With Dr. Fleming, he is co-editor of a book on modern occupational medicine published in 1954.

How Can a Company Lose?

The oil industry is lagging behind in adopting suggestion systems. Here are the reasons why . . .

William S. Wilcox
University College, Rutgers University
Newton Square, Penn.

THE OIL INDUSTRY, on its record, is a newcomer in the field of initiating employe suggestion systems. A short score of oil companies are operating these systems today but they include the most progressive and consistently profitable units in the industry.

The National Association of Suggestion Systems (headquarters Chicago) and the Suggestion Plans Association (headquarters Los Angeles) show well over a thousand industrial members representing all of the different industries of the country, but of petroleum members there are a scant baker's dozen.

A large portion of the oil industry seems to reject the probability that the ideas of its employes can increase efficiency or reduce costs through the facilities of a suggestion system. In the words of an unbiased petroleum researcher: "I've really done some leg work on this among companies without suggestion systems. I find that those who don't have such are adamantly opposed to the point of belligerency, and no amount of selling would convince them otherwise."

One company after a faint hearted trial run abandoned its suggestion system with the public statement to employes that all probable improvements had been made. Other companies, without recourse to a trial, have reasoned out loud that petroleum manufacturing processes 'on stream' offered too few opportunities for rank-and-file ideas, and in their view other operations such as marketing, distribution and producing provided no lucrative source of usable ideas.

Another major firm closed its mind firmly against an employe suggestion system on the basis that the company was entitled to such ideas as the employes had without having to pay for them. This point of view—though logical—is impractical because employes in their own thinking at all levels of a company are competing with other employes. That is the business system by which a company exists and its working out cannot be screened from employes. The goal of every employe is personal recognition and reward.

It is a significant circumstance that in not a few oil companies the employe thinking on suggestion systems is completely opposite to that of management—so much so that in two recently recorded instances (including one major Midwest company) unions have initiated general surveys of suggestion systems in industry as a foundation for 'selling' the idea to their company's management. This is a phenomena unusual in the employe minded consciousness of oil management.

By relying heavily on employe relations and benefit programs, management rarely applies the hard lessons of competition to their thinking about the employe group. Nor do they realize the need to provide active rewards and positive incentive to individual employes.

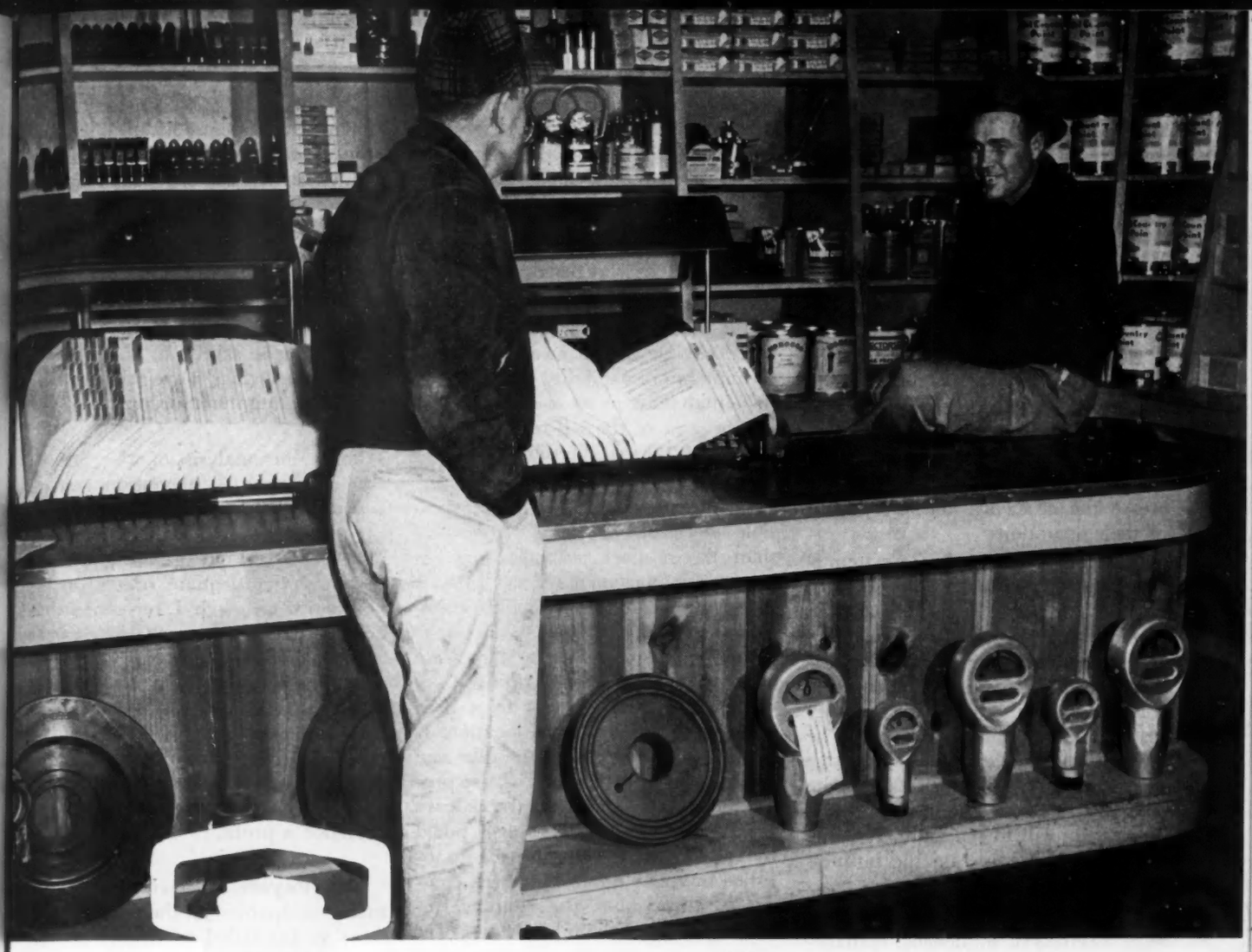
Pay Increases? When, as in some management thought, recognition and reward is confined to a sometime promotion and pay increase, the fulfillment of either may be improbable, even impossible in a selected case. The most idea minded employe may not be the best material for promotion—and a union negotiated pay scale or a maximum pay limit may not permit merit increases.

In fact, it seems uneconomic to grant a merit increase for an idea, or even a series of ideas. A pay increase goes on for a working lifetime whereas a suggestion award based on the immediate value of the idea or ideas compensates the employe and settles the account.

On the other hand, there is a tre-

SUGGESTION SYSTEMS offer three distinct advantages over the "open door" approach:

- **They certify that there is an official means for encouraging, handling and deciding on the use of employes' ideas.**
- **They provide a guide for management in selecting and awarding those ideas that are practical and usable.**
- **Results of the use of these means and guides are recorded in terms of performance which can be audited and evaluated.**



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mendous gain to a company through the facilities of a suggestion system in the daily re-affirmation to individual employe of the importance and vitality of personal initiative, of personal recognition and achievement. These benefits fulfill in a provable way the urge of people to imprint their personalities on the work they do.

Help Wanted—A proper aim of a suggestion system is to aid management at all levels in creating within the employe group an awareness of the need, and to provide incentives for employes to reduce costs and increase the efficiency and the output of their operations.

The concurrent goal of a system is to provide individual managers with facilities through which ideas from employes may be stimulated, recorded and evaluated and thereafter acknowledged in such a manner as to constitute an incentive to the suggester and to other employes. The most direct and dependable incentive used is a money award—it cancels the obligation and at the same time it creates the will to try again. It is the business way to operate the business venture of a suggestion system.

There are two more points which have seriously influenced management thought against the initiation of a suggestion system: Who is eligible for an award for what kind of an idea?

Here again, the way is clear and there need be no confusion or complication. The awards of a suggestion system should be available to rank-and-file employes whatever their job title and job responsibilities. This is the whole grass roots reservoir of brains that management needs to draw ideas from.

However, at succeeding levels of a company there are those who have supervision over other employes or who have assigned responsibilities for the initiation of new and improved methods. From all of these, technicians, engineers and researchers awards should be withheld for adopted ideas which have a direct effect on the processes of their assigned work.

To pay awards to these employes for ideas resulting in the increased production or the improvement of their job performance would in effect be paying twice—once by salary for the job and once by suggestion award for performance. It has been amply demonstrated in the operation of many companies that this small minority of potential suggesters rarely use the suggestion system to convey their ideas to management. In one group of 8000 such people, less than two hundred of them had used the formal system in a six year period—of these about 60 percent were found to be eligible for an award. The determination of eligibility hardly exists in actual practice as a serious problem because of the self-regulation exercised by these responsible people.

Is Morale Hurt? Finally, the possible rejection of more suggestions than the number accepted presents to some managements what appears to be a morale destroying problem, and therefore it is used as an argument against initiating a suggestion system. In practice the ratio of acceptances may range up to a near 100 percent in any given location. It depends on the employes' iniative and alertness, the intelligence of the promotion of the system and the care taken to analyze the problem posed by the idea itself. The records established by many major industrial companies throughout the country, including some of the oil industry, over a number of years clearly proves that a morale factor of rejection does not adversely affect a well run system.

One of the well run systems—The General Motors Corporation—recently reported to the public that last year it had received a record 192,030 suggestions from its employes of which 24 percent (i.e. 46,995) were adopted. Inasmuch as they paid out $2,467,513 in awards, the return to General Motors must have been substantial. The 75 percent rejection ratio does not react against the continued use of their suggestion system because year after year, they establish new high records for American industry.

Another company, a major unit in the oil industry, reports that in 1955, 40 percent of the individual suggesters received awards averaging $29 each—19 percent received two or more awards—75 percent of the individual suggesters were repeaters from previous years—and 25 percent were newcomers to the system.

A suggestion system should never be considered as an employes benefit nor should it be charged off as a labor burden. P. C. Salman, Comptroller of the Socony Mobil Oil Company, Inc., stated in a public address last year: "If the suggestion system is to compare favorably with other uses of corporate funds, it must reflect an adequate return, after covering all expenses—it takes a considerable amount of money to establish and maintain a suggestion system until it can be said that 'accumulated suggestion savings' have provided the working capital requirements of the system."

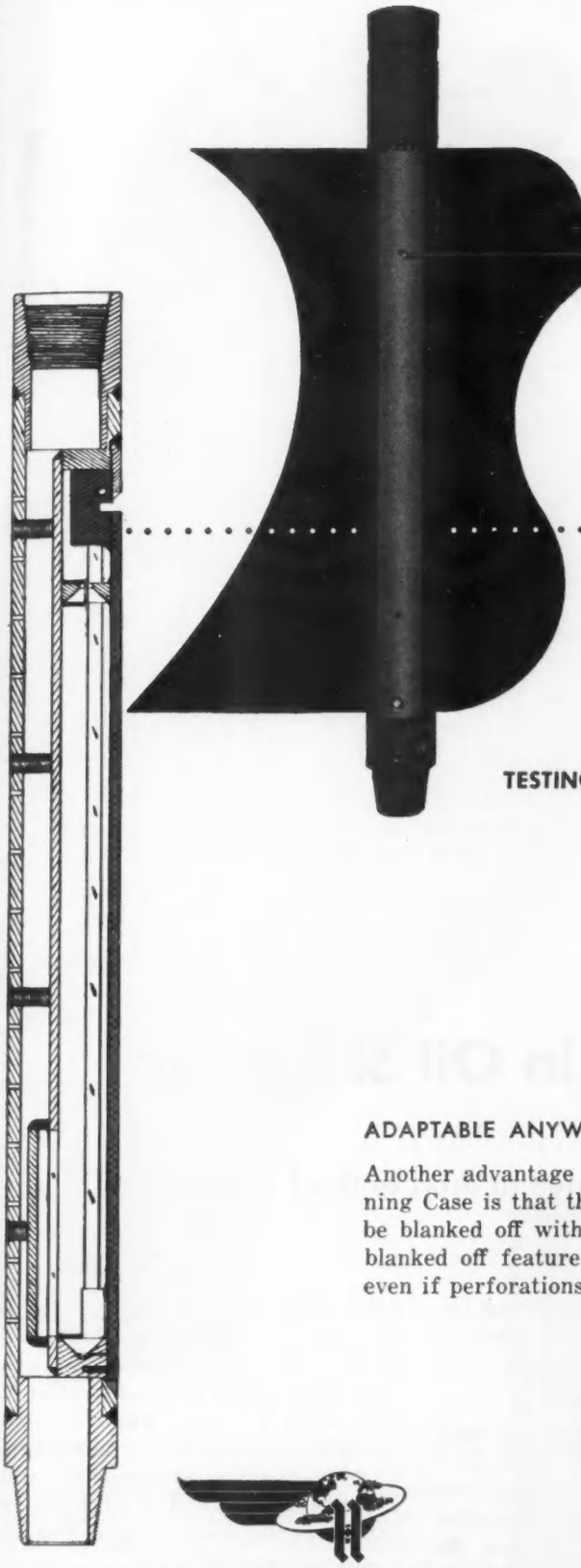
After an analysis of the Socony Mobil company's suggestion system, Salman concluded: "I look upon this suggestion system as an operation which has paid out promptly and has provided an adequate return on investment—although I recognize that payout and return on investment analysis are only tools used in aiding management's judgment, it does seem that most managements would be interested in an investment which can pay out in five years and earn 800 percent over 20 years." In substance, employes' ideas have cut costs and returned a profit.

The Payoff—Notwithstanding, many companies in the oil industry have so far failed to profit through the potential for increased efficiency and reduced costs that exists in the brains of rank-and-file employes. The industry has depended in great degree upon the static incentives of job assurance and fringe benefits and the even less tangible satisfactions as a way of influencing employes to propose ideas for improvements. There is no proof that employes are responding to these static incentives in any substantial manner.

For the industry to ensure to itself all the potential benefits inherent in employes' ideas, an active and a more impelling incentive is necessary—the suggestion system is a facility readily available to companies in the industry. It can and should be operated as a business venture subject to auditing as to its costs and as to its return to a company, and it should be expected to return a profit.

In the words of the president of one of the largest of the world-wide petroleum operations summing up his approval of suggestion systems: "How can a company lose?"

—The End



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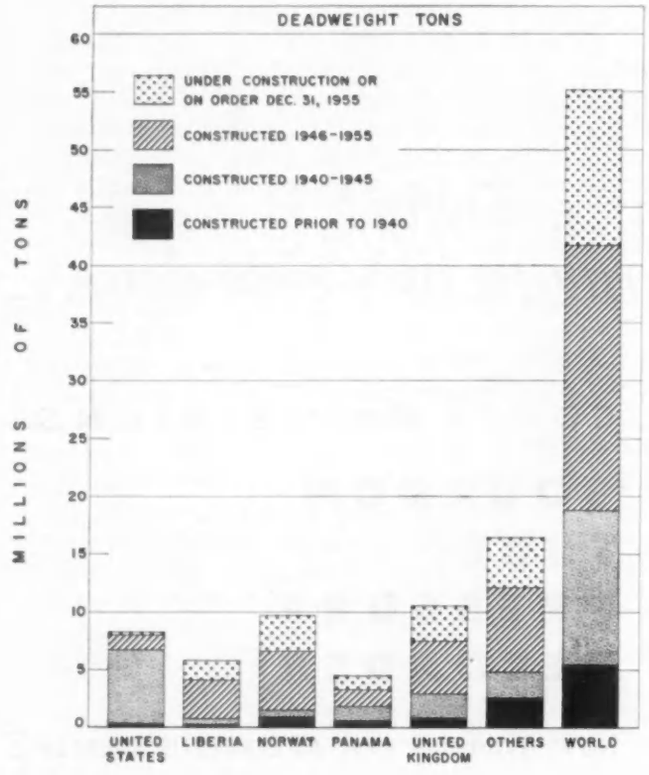

FIGURE 1—Age analysis of tank ship fleets of major flags and tank ships under construction or on order December 31, 1955. Ocean-going vessels 2000 gross tons and over.

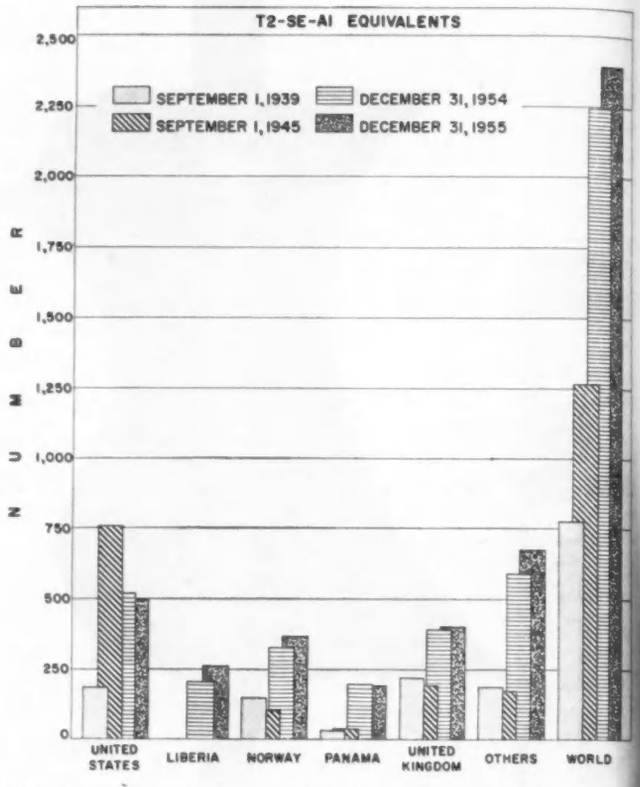

FIGURE 2—Tank ship fleets of major flags on selected dates. Ocean-going vessels 2000 gross tons and over.

U. S. to Lose No. 1 Rank in Oil Shipping

Aging American tankship tonnage due to drop to third in world by 1960.

THE U. S. TANKER fleet was still the world's biggest at the end of 1955 by a modest margin, with the United Kingdom second and Norway third. Projecting current trends, however, the U. S. will drop to third place behind these two European countries unless present trends are reversed. An exhaustive report "Analysis of World Tank Ship Fleet, December 31, 1955" by the statistical research department, Sun Oil Company, recently released, validates a number of trends cited in a similar report completed last year.

The most significant analyses are effected by stating the world tanker fleet in terms of T2, or more precisely, T2-SE-Al tank ship equivalents. Such a vessel is defined as one having 16,765 deadweight tons and a speed of 14.5 knots. The most important trends noted are as follows:

1. The world tanker fleet increased during 1955 to 2681 ships of 2000 gross tons or more, representing a net increase of 79 ships from December 31, 1954, or three percent over the previous year. The deadweight tonnage increased by 6.3 percent to 41,623,100 during the same period. The larger percentage increase in tonnage as compared to number of ships also cites the trend toward larger ships.

2. At the same time, U. S.-registered tankers decreased by 24.3 T-2 equivalents, from 521.7 to 497.4, a drop of 4.7 percent. In terms of deadweight tons, the U. S. fleet dropped from 8,446,200 at the end of 1954 to 7,989,500 a year later. The U. S. thus had 20.8 percent of the world's oil carrying capacity, as compared with 23 percent at the end of 1954 and 60 percent at the close of World War II.

3. Great Britain remained in second place among the world's tanker fleets, with a total deadweight tonnage of 7,505,600, as compared with 7,374,600 at the close of 1954. The increase of only 131,000 tons is less than two percent, but Britain now has far more ships under construction than any

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other nation, and its tanker tonnage will jump abruptly upon completion of these vessels. At the end of 1955, 137 tank ships were being built in the United Kingdom, representing 3.5 million deadweight tons, about one-quarter of the world's tonnage then under construction.

Japan, Sweden, The Netherlands, and West Germany were the next four nations in order of greatest tonnage of tankers being built. In the U. S., only eight tankers, representing 239,500 deadweight tons, were being built at the end of 1955, continuing a tanker construction decline existent since 1952.

Great Britain's percentage of the world's fleet dropped from 17.7 percent at the end of 1954 to 16.9 percent a year later, as its rate of completion of tank ships failed to keep pace with the overall increase in the world fleet. Third-place Norway increased its percentage of the total from just under 15 percent at the end of 1954 to 15.4 percent a year later.

4. The tendency toward bigger tankers, cited previously, is shown by the fact that on December 31, 1955, 258 "supertankers," arbitrarily defined as tankers of 24,000 deadweight tons or more, were in service. They totaled 7,472,400 deadweight tons, or 485.4 T-2 equivalents. Thus the average "supertanker" afloat has almost twice the carrying capacity of the T-2, though the average tanker of 2000 gross tons or more had less than the carrying capacity of the T-2 at the end of 1955. At the end of 1954, there were 216 supertankers in service, increasing by 42 or 19.4 percent a year later. In terms of the world's carrying capacity, supertankers represented 20.2 percent of the total at the start of 1956, as compared with 17.8 percent at the end of 1954 and only 13.4 percent a year earlier.

5. Liberia now has 10.9 percent of the world's tanker fleet. All of it has been acquired since the end of World War II. One of the factors contributing both to the U. S. decrease and the Liberian increase was the transfer of 20 T-2's to Liberian registry. During 1955, the Liberian fleet increased by 28.1 percent in carrying capacity, gaining 36.7 T-2 equivalents. As recently as September, 1949, the little West African nation had only 1.2 percent of the world's tanker fleet.

6. Many ships of foreign registry are actually under control of U. S. companies. At the end of 1955, 823 tankers were under U. S. control, of which 490 flew the American flag and 333 were owned by U. S. companies or their subsidiaries, sailing under foreign registries. Despite a gain in T-2 equivalents of tankers controlled by the U. S., the portion of the world fleet so controlled dropped from 37.4 percent at the end of 1954 to 35.5 percent a year later.

7. The greatest variation among the world's tanker fleets occurs in the aspect of age. The U. S. fleet, which averages 10 years 9 months in age, is threatened more strongly with block obsolescence than any other major tanker fleet. Panama's fleet averages 9 years and 8 months. Liberia's fleet is the youngest of the majors, only 4 years 8 months for the average tanker. Great Britain (7 years 8 months) and Norway (6 years 7 months) were below the average world fleet age of 8 years 3 months as of the end of 1955. Generally the world's fleet appears to be getting younger. During 1955 the average age of the U. S. fleet became greater, Norway's fleet grew younger, and Britain's remained the same.

Construction. At the end of 1955, tankers known to be under construction or on order aggregated 513 of 2000 gross tons or more, representing 13.6 million deadweight tons, up 98 ships and 4.2 million dwt. from a year before. This represents 19.1 percent of the number of ships then in service, and 32.7 percent of the carrying capacity, again stressing the trend toward supertankers. Assuming no additions to the world fleet not now on order, no interflag transfers, no more conversions to dry cargo, and scrapping of all tankers reaching 25 years of age, by 1960 the United Kingdom will have 10.3 million, Norway 9.3 million, and the U. S. 8.2 million, deadweight tons respectively at that time. Norway's fleet would be expected to increase by 40 percent, Liberia's by 37.9 percent, the U.K.'s by 37 percent, Panama's by 27.4 percent, while the U. S. fleet would increase by only 2.5 percent by 1960, as compared with an over-all 25.1 percent in the world fleet.

At the end of 1955, the average deadweight tonnage of the world fleet was 15,500 tons, less than T-2, but a 3.34 percent increase over the previous year. During the same period, average speed increased from 13.9 to 14.0 knots, again less than that of the T-2.

Due to shallow draft (27 feet) and small size of locks, only seven percent of the world's tanker fleet will be able to use the St. Lawrence Seaway fully loaded when this artery is completed, unless plans change.

Ownership of the world's tankship fleet remained essentially in the same proportions during 1955. At the end of the year, oil companies owned 34 percent, non-oil companies owned 55.8 percent, and governments, 10.2 percent. —**The End**

WORLD TANK SHIP FLEET, BY FLAG, NOW AND 5 YEARS HENCE

FLAG	12-31-55 Actual Fleet		Under Construction or on Order 12-31-55		Scrappage 1956-1960	Actual Fleet Plus Construction and Orders Less Scrappage	
	Deadweight Tons	Percent of World	Deadweight Tons	Percent of World	Deadweight Tons	Deadweight Tons	Percent of World
United States	7,989,500	19.2	239,500	1.8	40,300	8,188,700	15.7
Liberia	4,152,400	10.0	1,683,700	12.4	113,700	5,722,400	11.0
Norway	6,607,800	15.9	3,100,300	22.7	459,100	9,249,000	17.8
Panama	3,275,900	7.9	1,235,000	9.0	338,300	4,172,600	8.0
United Kingdom	7,505,600	18.0	3,090,400	22.7	310,900	10,285,100	19.7
Others	12,091,900	29.0	4,275,300	31.4	1,903,000	14,464,200	27.8
World Total	41,623,100	100.0	13,624,200	100.0	3,165,300	52,082,000	100.0

By **RAY L. DUDLEY,** Publisher, and **WARREN L. BAKER,** Editor

Crude Oil Prices Are in Danger

Sharp import growth pushes supply above needs in recent months.

THERE IS DANGER of a U. S. crude oil price cut. During recent weeks supply has exceeded needs by an increasing margin. Three million barrels were added to U. S. crude oil stocks during the month of July. At the end of July, stocks of crude were 18 million barrels higher than 5 months ago.

Consequently, a few widely scattered local price cuts have occurred in recent months. Although local in nature, they are signs of an ailing market. Unless the basic trouble—too much crude oil—is corrected, additional price reductions can be expected in other spots. These could easily lead to a general across-the-board price cut.

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CHIEF CAUSE of excessive supplies is increased imports. More than 195¾ million barrels of crude oil were imported into the U. S. during the first seven months of 1956. This was 36¼ million more barrels than imported during the corresponding period of 1955, a whopping increase of 22.7 percent.

Of greater significance was the failure of imports to follow the normal seasonal demand pattern. Imports of crude have increased steadily to ever greater all-time peaks in recent months, when demand for petroleum products was following the normal seasonal pattern of being less than during winter months.

If imports are to supply a substantial portion of the U. S. crude oil market, they should not go contrary to seasonal demand trends. The lowest requirements of the year invariably occur during April and May, with a gradual increase thereafter until a peak is reached the following January and February.

Importers went contrary to this seasonal pattern in 1956, as shown in the accompanying table. Crude oil imports rose sharply following an encouraging cutback in April. In July they reached an all-time peak of 1,081,000 barrels per day, 221,000 more than in July, 1955, and 256,000 barrels per day above April of this year.

•

SOME OF THE BLAME for excessive supplies also rests with U. S. producers and some state regulatory boards, who have wanted to produce more oil than demand indicated as being desirable.

During the first seven months of 1956, the U. S. produced 90 million more barrels (6.5 percent) of oil than in the same period of 1955. Texas produced 30¾ million more barrels so far in 1956 than in 1955, a gain of 5.0 percent. Louisiana produced 18⅔ million more barrels, an increase of 12.3 percent. Oklahoma produced nearly 11 million barrels more, a gain of 9.4 percent. Wyoming produced 3¼ million more barrels, up 5.6 percent from 1955.

Contrary to the trend in imports, U. S. production has been curtailed in recent months to compensate for lower demand. However, the reduction has not been sufficient. During May, June and July, U. S. crude production was held to an average of around 7,050,000 barrels daily compared with approximately 7,250,000 barrels during the first three months of the year. Nevertheless, output during recent months has been almost half a million barrels per day above 1955 levels.

There has been a desire on the part of some producers and some regulatory bodies to produce larger quantities in an attempt to "flood" imports out of the U. S. crude markets. Such action can lead only to reduced U. S. crude oil prices, which would be more injurious to domestic producers than to foreign producers.

•

EXCESSIVE GASOLINE STOCKS further weaken the market and increase prospects of a crude oil price cut. Inventories of U. S. motor fuel on August 17 totaled 176 million barrels, 20¾ million more than a year ago.

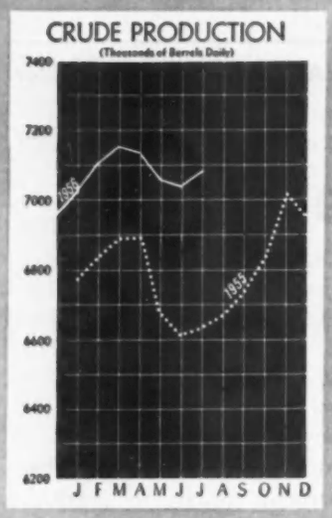
This situation has been obvious for six months, but refiners so far have failed to heed the warning. They have had every opportunity. Gasoline demand has been at record levels. Distillate fuel stocks need enlargement, being below year-ago levels.

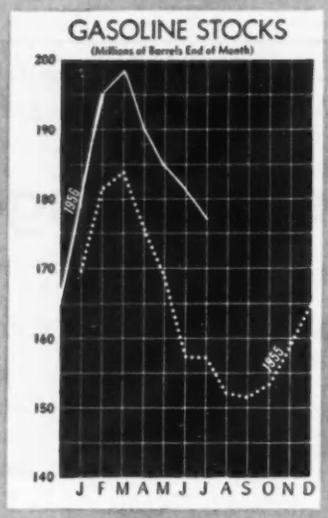
With the heavy motor fuel season rapidly approaching, little time remains in which to work off excess quantities. Only quick and substantial reduction of gasoline output can now prevent a serious surplus during coming winter months.

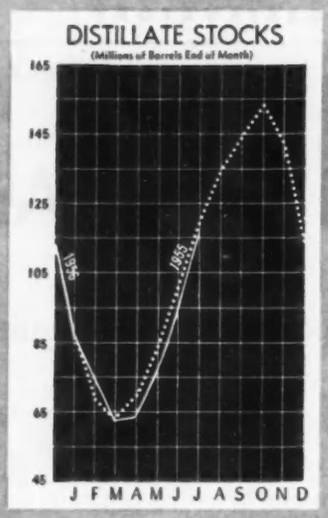
•

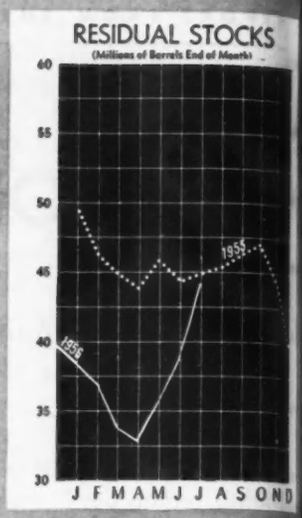
Daily Average U. S. Crude Oil Imports

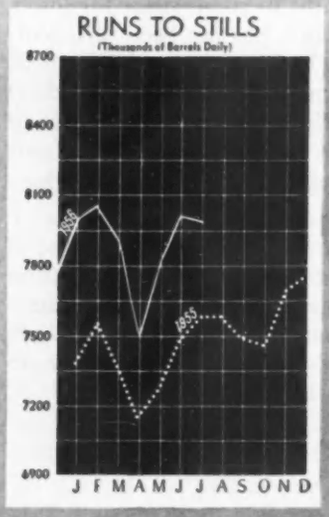
	1956	1955	Increase
January	805,000	739,000	66,000
February	878,000	751,000	127,000
March	934,000	742,000	192,000
April	815,000	697,000	118,000
May	919,000	742,000	177,000
June	976,000	764,000	212,000
July	1,081,000	860,000	221,000

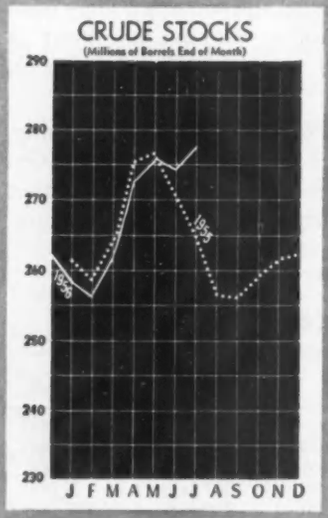












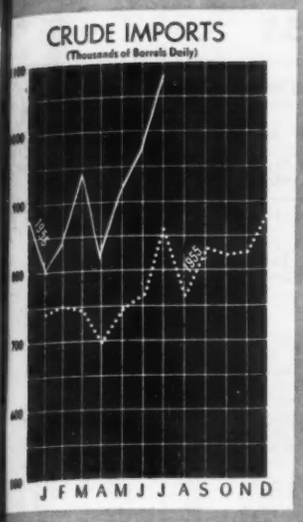
Petroleum Trends In U.S. . . .

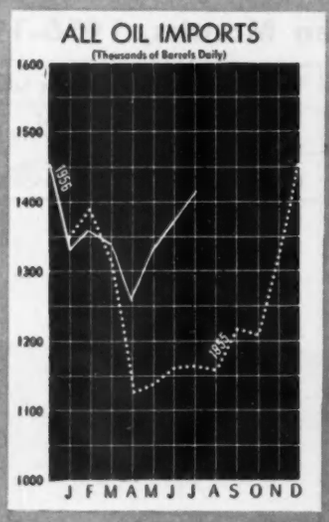
By CECIL W. SMITH, World Oil Staff

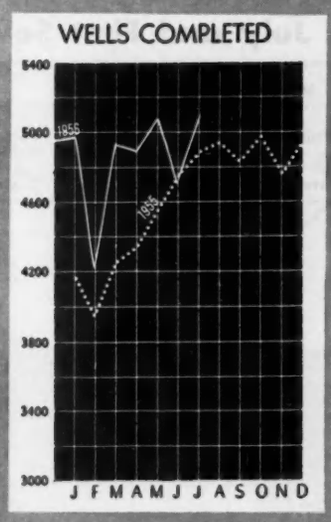
U. S. Crude Production by States

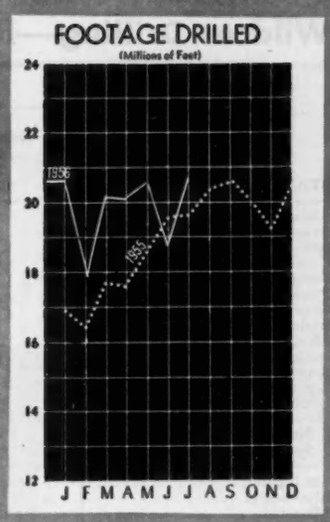
(THOUSANDS OF BARRELS)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION July, 1956	June, 1956	July, 1955	% Diff. July, '56-'55	TOTAL PRODUCTION First Seven Months 1956	1955	% Diff. '56-'55
Alabama	6.9	5.6	3.8	+ 81.7	1,250	777	+ 60.9
Arkansas	75.9	75.5	76.7	— 1.1	16,461	16,613	— 0.9
California	958.3	962.2	972.7	— 1.5	205,666	205,898	— 0.1
Colorado	164.5	165.9	146.3	+ 12.4	34,695	27,908	+ 24.3
Florida	1.3	1.3	1.4	— 7.2	286	279	+ 2.5
Illinois	228.6	228.0	224.1	+ 2.0	48,278	46,719	+ 3.3
Indiana	31.4	31.5	30.8	+ 1.9	6,271	6,363	— 1.5
Kansas	343.5	343.1	339.7	+ 1.1	72,708	70,651	+ 2.9
Kentucky	48.1	47.8	41.7	+ 15.3	10,210	8,560	+ 19.3
Louisiana	786.2	787.9	718.4	+ 9.4	170,771	152,113	+ 12.3
North Louisiana	122.6	125.5	119.3	+ 2.8	26,800	25,120	+ 6.7
South Louisiana	663.6	663.4	559.1	+ 18.7	143,971	126,993	+ 13.4
Michigan	28.4	29.4	29.7	— 4.4	6,423	6,626	— 3.1
Mississippi	111.7	111.0	101.3	+ 10.3	23,600	20,599	+ 14.6
Missouri	0.2	0.1	0.2	.....	36	40	— 10.0
Montana	63.5	62.1	41.0	+ 54.9	12,338	9,190	+ 34.3
Nebraska	38.9	38.5	26.8	+ 45.1	8,662	5,175	+ 67.4
Nevada	0.2	0.2	0.2	.....	43	41	+ 4.9
New Mexico	235.9	242.8	222.1	+ 6.2	50,792	46,952	+ 8.2
Southeast New Mexico	234.1	241.3	219.5	+ 6.7	50,191	46,355	+ 8.3
Northwest New Mexico	1.8	1.5	2.6	— 30.8	601	597	+ 0.7
New York	10.2	10.2	7.7	+ 32.5	1,783	1,701	+ 4.8
North Dakota	35.0	26.0	36.8	— 4.9	7,522	6,057	+ 24.2
Ohio	13.5	12.8	11.2	+ 20.5	2,710	2,407	+ 12.6
Oklahoma	585.0	585.6	550.0	+ 6.4	127,286	116,377	+ 9.4
Pennsylvania	20.1	19.8	23.7	— 15.2	4,607	4,872	— 5.4
South Dakota	0.1	0.1	0.1	.....	17	23	— 26.1
Tennessee	0.1	0.1	.....	.....	8	11	— 27.3
Texas	3,002.7	2,977.2	2,731.1	+ 9.9	646,639	615,887	+ 5.0
Dist 1: South Central	56.4	55.2	48.6	+ 16.0	11,491	10,852	+ 5.9
Dist. 2: Middle Gulf	154.4	158.4	139.3	+ 10.8	33,659	32,180	+ 4.6
Dist. 3: Upper Gulf	457.3	449.9	439.3	+ 4.1	96,949	97,540	— 0.6
Dist. 4: Lower Gulf-S.W.	239.8	240.7	227.8	+ 5.3	52,245	52,350	— 0.2
Dist. 5: East Central	44.2	45.4	47.4	— 6.8	9,751	10,167	— 4.1
Dist. 6: Northeast	339.0	337.7	321.0	+ 5.6	73,751	74,185	— 0.6
Dist. 7-B: North Central	156.2	152.6	139.8	+ 11.7	33,208	29,831	+ 11.3
Dist. 7-C: West Central	186.2	189.2	174.2	+ 6.9	39,386	39,794	— 1.0
Dist. 8: West	1,056.4	1,044.1	902.2	+ 17.1	222,473	199,866	+ 11.3
Dist. 9: North	215.4	209.8	191.8	+ 12.3	44,767	42,131	+ 6.3
Dist. 10: Panhandle	97.4	94.2	89.9	+ 8.3	20,122	18,536	+ 8.6
Utah	4.9	5.2	6.1	— 19.7	1,077	1,202	— 10.4
Virginia	0.1	0.1	0.1	.....	7	7	.....
West Virginia	6.0	6.0	6.1	— 1.6	1,280	1,374	— 6.9
Wyoming	286.8	277.4	282.5	+ 3.4	60,835	57,596	+ 5.6
Total United States	7,088.0	7,056.9	6,632.3	+ 6.9	1,522,261	1,432,018	+ 6.3







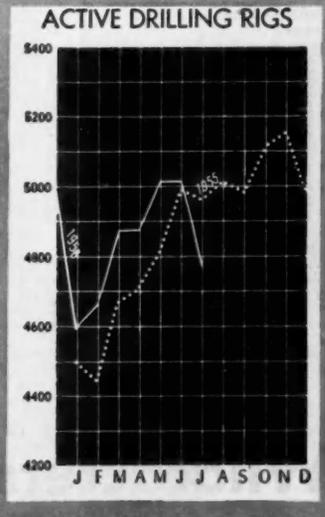


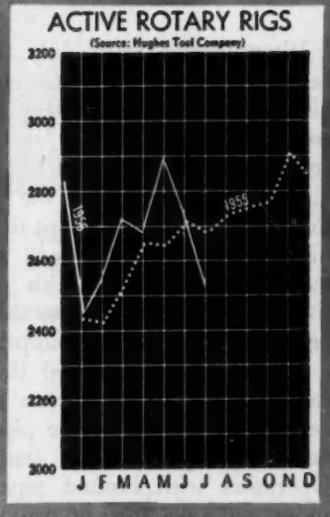
- **July's wells at all-time peak**
- **Crude output makes slight gain**
- **Crude imports hit highest level**

Crude Oil and Refined Products Trends
(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1954:											
June	6,500	6,947	285,155	3,483	165,404	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	1,416	101,657	1,089	54,365	724	1,033
August	6,168	6,862	281,043	3,492	153,168	1,453	117,579	1,069	56,322	664	966
September	6,151	6,939	274,608	3,511	150,916	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	1,668	108,144	1,187	52,105	729	1,301
1955:											
January	6,761	7,379	260,156	3,639	169,562	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	1,847	68,512	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	1,621	143,248	1,061	46,267	829	1,218
October	6,831	7,465	267,346	3,827	153,103	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	1,765	111,333	1,286	39,174	884	1,502
1956:											
January	7,199	8,023	261,592	3,927	183,905	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	1,667	75,928	1,149	36,607	938	1,416
June	7,045	8,048	274,677	3,906	180,729	1,751	94,993	1,115	38,776	976	1,371
July	7,088	8,011	277,546	3,895	177,416	1,808	117,664	1,105	44,189	1,081	1,408
July, 1956 Change:											
In Month	+43	−37	+2,869	−11	−3,313	+57	+22,671	−10	+5,413	+105	+37
In Year	+456	+431	+12,945	+71	+20,337	+233	−1,505	+14	−705	+221	+247
Week Ended:											
8-10-56	7,086	8,049	274,389	3,933	177,557	1,760	124,173	1,123	45,541	807	1,213
8-12-55	6,635	7,670	264,517	3,792	154,983	1,623	122,214	1,141	45,705	779	1,080

Source: Data for last two months from API; prior monthly data from Bureau of Mines.





Wildcat Drilling—in July and First Seven Months, 1956-1955

STATE or DISTRICT	MONTH OF JULY, 1956						FIRST SEVEN MONTHS, 1956-1955									
	New Fields			Total Discoveries	Dry Wildcats	Total Wildcat Tests	New Fields			Total Discoveries		Dry Wildcats		Total Wildcat Tests		
	Oil	Distillate	Gas				Oil	Distillate	Gas	7 Mo. 1956	7 Mo. 1955	7 Mo. 1956	7 Mo. 1955	7 Mo. 1956	7 Mo. 1955
Alabama	..	..	..	....	2	2	...	..	1	1	...	17	30	18	30
Arizona	..	..	..	....	4	4	...	..	...	...	...	4	4	4	4
Arkansas	3	..	..	3	13	16	9	..	3	12	10	74	68	86	78
California	5	..	1	6	23	29	6	..	4	10	15	141	173	151	188
Colorado	2	..	..	2	57	59	17	1	6	24	40	346	442	370	482
Florida	..	..	..	....	1	1	...	..	...	...	...	7	19	7	19
Georgia	..	..	..	....	2	2	...	..	...	...	...	5	....	5	....
Idaho	..	..	..	....	....	....	...	..	...	...	1	1	2	1	3
Illinois	4	..	..	4	99	103	13	..	1	14	14	552	377	566	391
Indiana	..	..	..	....	11	11	1	..	...	1	10	90	103	91	113
Kansas	4	..	..	4	103	107	100	..	16	116	117	607	536	723	653
Kentucky	1	..	..	1	23	24	3	..	...	3	14	91	63	94	77
Louisiana	11	5	3	19	55	74	26	19	13	58	40	307	265	365	305
North Louisiana	4	1	1	6	23	29	5	1	1	7	7	112	101	119	108
South Louisiana	7	4	2	13	32	45	21	18	12	51	33	195	164	246	197
Michigan	..	..	..	....	18	18	3	..	...	3	2	90	111	93	113
Mississippi	3	..	..	3	21	24	6	2	...	8	7	98	97	106	104
Missouri	..	..	..	....	4	4	...	..	...	...	...	15	17	15	17
Montana	..	..	1	1	23	24	5	..	2	7	5	80	55	87	60
Nebraska	2	..	..	2	37	39	28	..	...	28	23	264	182	292	205
Nevada	..	..	..	....	2	2	...	..	...	...	...	3	4	3	4
New Mexico	1	..	..	1	26	27	25	1	1	27	32	119	89	146	121
North Dakota	1	..	..	1	14	15	9	..	...	9	3	46	26	55	29
Ohio	..	..	..	....	....	....	...	..	...	...	1	3	13	3	14
Oklahoma	8	1	3	12	48	60	55	12	19	86	77	405	351	491	428
Oregon	..	..	..	....	....	....	...	..	...	...	...	1	1	1	1
Pennsylvania	..	..	..	....	....	....	...	..	...	...	1	....	2	....	3
South Dakota	..	..	..	....	3	3	...	..	...	...	...	7	6	7	6
Texas	53	..	4	57	423	480	311	22	52	385	393	2,794	2,377	3,179	2,770
Dist. 1: South Central	..	..	..	....	54	54	14	..	4	18	21	295	231	313	252
Dist. 2: Middle Gulf	2	..	..	2	25	27	7	4	4	15	23	149	143	164	166
Dist. 3: Upper Gulf	1	..	..	1	41	42	14	7	4	25	30	250	241	275	271
Dist. 4: Lower Gulf-S.W.	3	..	2	5	49	54	12	6	11	29	35	254	237	283	272
Dist. 5: East Central	..	..	..	....	14	14	...	..	...	...	5	77	80	77	85
Dist. 6: Northeast	2	..	..	2	13	15	9	1	2	12	6	130	108	142	114
Dist. 7-B: North Central	7	..	2	9	67	76	96	..	8	104	99	591	510	695	609
Dist. 7-C: West Central	3	..	..	3	27	30	25	..	2	27	27	158	164	185	191
Dist. 8: West	16	..	..	16	37	53	59	2	2	63	47	262	262	325	309
Dist. 9: North	17	..	..	17	81	98	65	..	6	71	93	576	373	647	466
Dist. 10: Panhandle	2	..	..	2	15	17	10	2	9	21	7	52	28	73	35
Utah	..	..	..	....	6	6	2	..	2	4	9	53	35	57	44
Washington	..	..	..	....	....	....	...	..	...	...	...	1	....	1	....
West Virginia	..	..	..	....	....	....	...	..	...	...	7	....	10	....	17
Wyoming	..	..	..	....	22	22	5	1	3	9	18	126	100	135	118
Total United States	98	6	12	116	1,040	1,156	624	58	123	805	839	6,347	5,558	7,152	6,397

Wildcatters Busy in July

The month became the most active in history, and the year's tests were boosted to a 12% lead.

WILDCATTERS MADE July the most active exploratory drilling month in history. This new monthly peak in completed wildcat wells swelled the year's seven-months total to a lead of almost 12 percent over the previous most active year, 1955. But the immediate months to come will probably see a slackening from this peak activity as rigs are forced to shut down because of lack of pipe supplies.

However, it is believed that wildcatting will be retarded less than development drilling by the pipe shortage resulting from the steel strike. Operators with limited pipe inventories will take care of drilling commitments first, leaving the in-drilling to a later date when pipe is available.

July's activity resulted in the greatest number of completed wells ever recorded in a single month, but the successful results were not very promising. In fact, the month's efforts fell short of the year's average success rate and were not particularly encouraging.

A total of 1156 wildcat wells was completed during July, and of these, 116 were rated as discoveries of commercial oil, gas or distillate. That figured to be only 10 percent productive, while the year's seven-months average was 11.3 percent.

The month's 116 discoveries were made up of 98 new oil fields and 18 new gas or distillate fields. A month earlier, 110 discoveries had been made by considerably fewer tests drilled.

So far this year, wildcat wells totaled 7152 to top the 6397 recorded in the same period of 1955 by 11.8 percent. Wildcatting this year has enjoyed a substantially greater gain over the previous year's activity than has development drilling. While exploration has gained 11.8 percent, field development activity has showed an increase of only 7.7 percent over last year's operations.

Summary of Results of Wildcat Drilling

ITEM	July, 1956	June, 1956	SEVEN MONTHS January-July 1956	1955	Percent Diff.
New Field Discoveries:					
Oil	98	83	624	633	— 1.4
Distillate	6	7	58	73	—20.6
Gas	12	20	123	133	— 7.5
Total Discoveries	116	110	805	839	— 4.1
Dry Wildcats	1,040	862	6,347	5,558	+14.2
Total Wildcats	1,156	972	7,152	6,397	+11.8
Percent Productive	10.0	11.3	11.3	13.1	.....
Percent Dry	90.0	88.7	88.7	86.9	.....

qualities
essential to
leadership
in geophysical
instrumentation

SOUTHWESTERN INDUSTRIAL
ELECTRONICS COMPANY
2831 POST OAK ROAD • P. O. BOX 13058
HOUSTON 19, TEXAS

222-55

U. S. Wells Completed in July and First Seven Months, 1956—1955

STATE or DISTRICT	NEW WELLS COMPLETED AND FOOTAGE DRILLED — DETAILS FOR JULY: Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	TOTAL NEW WELLS: July 1956	June 1956	July 1955	Total Footage July, 1956	DETAILS FOR JANUARY-JULY — NEW WELLS: 1956	1955	Percent Diff.	FOOTAGE: 1956	1955	Rigs in Operation: July 31, 1956	June 30, 1956	July 31, 1955
Alabama	7			3				10	10	2	88,969	56	31	+ 80.6	444,923	128,350	15	12	3
Arizona				4				4			4,000	4	4		4,000	16,136	3	2	1
Arkansas	61			30				91	74	82	280,888	498	416	+ 19.7	1,566,690	1,318,787	56	53	71
California	137		5	42				184	165	206	942,218	1,245	1,517	— 17.9	5,890,862	6,954,770	184	200	236
Colorado	22		5	72				99	97	143	524,748	750	860	— 12.8	3,945,850	4,997,755	70	78	103
Florida				1				1		3	4,119	7	20	— 65.0	39,121	130,552	1	1	5
Georgia				2				2			9,189	5			22,008			1	1
Idaho										1		1	3	— 66.7	4,528	11,337	1	1	
Illinois	178		3	184				365	403	428	853,852	2,151	2,134	+ 0.8	5,047,972	5,134,153	302	331	333
Indiana	23			35				58	52	58	106,004	361	349	+ 3.4	630,402	520,541	85	91	98
Kansas	173		23	181	4		1	382	457	421	1,331,927	2,745	2,701	+ 1.6	9,672,039	9,851,302	486	475	458
Kentucky	70		16	98	2			186	151	172	278,795	1,043	889	+ 17.3	1,516,373	1,439,746	136	134	137
Louisiana	173	13	39	131				356	294	335	2,549,623	2,136	2,367	— 9.8	15,889,639	14,977,590	413	427	364
North Louisiana	98	1	16	58				173	133	169	631,520	883	1,217	— 27.5	3,206,161	3,589,796	79	85	78
South Louisiana	75	12	23	73				183	161	166	1,918,103	1,253	1,150	+ 9.0	12,683,478	11,387,794	334	342	288
* Gulf of Mexico	13	2	2	14				31	31	22	280,295	217	177	+ 22.6	1,979,949	1,652,941	62	75	40
Maryland												4			30,716				3
Michigan	13			23				36	49	37	103,646	271	291	— 6.9	767,848	854,141	71	69	93
Mississippi	8		1	29				38	37	35	261,113	248	279	— 11.1	1,798,366	2,095,203	33	30	35
Missouri				4				4	2		5,716	21	24	— 12.5	23,811	13,095	1	1	3
Montana	19		1	30				50	38	29	221,085	245	167	+ 46.7	1,222,283	841,902	64	46	55
Nebraska	32			52				84	98	82	510,909	596	445	+ 33.9	3,439,401	2,566,369	31	33	54
Nevada				2				2			3,819	5	6	— 16.7	28,571	44,828	3	2	1
New Mexico	92		70	38				200	181	172	834,759	1,147	987	+ 16.2	5,148,169	4,189,114	190	210	158
New York	27				17			44	46	29	60,900	241	192	+ 25.5	338,100	265,520	65	67	49
North Dakota	13			17				30	20	21	182,818	169	136	+ 24.3	1,256,299	991,470	27	21	25
Ohio	50		13	18				81	82	111	194,343	580	650	— 10.8	1,421,702	1,353,650	216	209	212
Oklahoma	394	1	28	226	10		7	666	610	715	2,367,683	4,786	4,397	+ 8.8	17,201,426	14,826,714	634	647	634
Oregon												1	1		12,880	7,101			
Pennsylvania	23		20	4	23	1		71	76	67	195,182	463	425	+ 8.9	1,302,448	801,784	155	143	120
South Dakota				3				3	1		14,277	7	6	+ 16.7	42,713	35,579	2	4	3
Texas	1,176	24	60	664	11			1,935	1,763	1,661	8,368,478	13,227	11,213	+ 18.0	55,779,288	48,882,028	1,205	1,413	1,383
Dist. 1: South Central	103		1	83				187	169	144	462,927	1,236	1,030	+ 20.0	3,300,682	2,697,980	54	64	50
Dist. 2: Middle Gulf	20	4	4	32				60	64	65	388,549	487	459	+ 6.1	3,046,232	2,742,713	41	45	49
Dist. 3: Upper Gulf	93	12	5	65				175	132	165	1,175,222	1,068	1,045	+ 2.2	7,110,070	6,669,170	151	147	136
* Gulf of Mexico										1		4	8	— 50.0	40,088	81,201	6	3	3
Dist. 4: Lower Gulf-S.W.	37	8	15	73				133	150	102	722,122	871	801	+ 8.7	4,611,788	4,170,066	67	78	87
* Gulf of Mexico										1		6	8	— 25.0	60,723	77,187	2	2	2
Dist. 5: East Central	6			21				27	13	21	86,231	149	158	— 5.7	499,316	623,903	11	7	14
Dist. 6: Northeast	34		11	29				74	71	70	424,627	523	405	+ 29.1	2,777,909	2,210,437	67	67	65
Dist. 7-B: North Central	120		1	51				172	252	301	688,039	1,785	1,801	— 0.9	6,296,962	5,627,204	112	140	160
Dist. 7-C: West Central	75		1	30				106	87	91	403,552	742	713	+ 4.1	3,357,380	3,840,655	106	136	127
Dist. 8: West	369		3	59	1			432	322	272	2,277,190	2,456	2,117	+ 16.0	12,540,156	11,395,978	297	357	391
Dist. 9: North	216		3	197	10			426	385	373	1,165,104	3,099	2,125	+ 45.8	9,136,774	6,935,435	202	257	228
Dist. 10: Panhandle	103		16	24				143	118	57	574,915	811	559	+ 45.1	3,102,019	1,968,487	97	115	76
Utah	5			7				12	8	10	58,822	84	58	+ 44.8	397,463	275,264	33	29	23
Washington												1			7,493				
West Virginia	5		37	7				49	58	61	123,724	399	349	+ 14.3	1,045,674	920,169	185	190	190
Wyoming	30		4	37				71	65	74	308,912	515	421	+ 22.3	2,389,050	2,053,055	108	99	114
Total United States	2,731	38	325	1,944	67	1	8	5,114	4,839	4,955	20,790,518	34,012	31,338	+ 8.5	138,328,108	126,100,005	4,775	5,019	4,965
Total Western Canada	157		2	12			3	174	174	284	806,150	1,142	1,369	— 16.6	5,484,674	5,803,596	230	211	209

* Gulf of Mexico wells are included in their respective District totals.

Drilling Peak Hit in July

Year's wells lead 1955's by 8.5 percent, but steel strike's dampening effects start to show.

WELLS COMPLETED during July totaled up to the greatest number ever recorded in a single month, and pushed the year's seven-months total to an 8.5 percent lead over last year's record volume. However, the month's record-shattering activity was not destined for long life, because by the end of the period the pipe shortage, born of the steel industry strike, was beginning to take its toll.

Rate of completing wells had not slowed down materially by the end of the month, for that will be in evidence in the coming months' statistics, but the number of active drilling rigs was reflecting the unfortunate situation of a number of operators who had run out of pipe. Almost 250 drilling rigs were made inactive during the month and more were sure to follow before pipe supplies would allow them to go back to work.

Magnitude of the strike's effects on the industry's drilling program is yet to be determined, but there can be no doubt that fewer wells will be drilled this year because of it.

July's wells amounted to 5114 to top the previous monthly peak drilled in May of this year. Ordinarily July is not the most active drilling month, but it may be this year thanks to the strike's dampening effects. Despite the setback, U. S. drillers are expected to drill more than 59,000 new wells this year for an all-time record.

In seven months, new wells added to 34,012 for a lead of 8.5 percent over the 31,338 completed in the same period of last year. Total footage drilled in the same period amounted to more than 138 million feet, representing an increase of 9.7 percent over the 126 million feet drilled a year earlier.

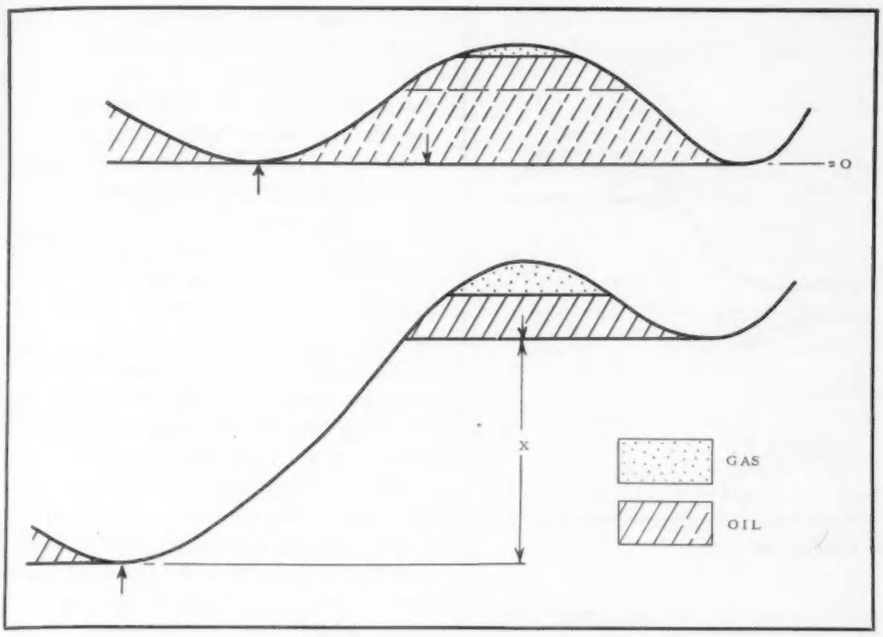


FIGURE 1—Solution-gas gas cap.

Time Accumulation and Evolution of Hydrocarbons

Hydrocarbon formation, mechanics of fluid travel and influence of bacteria are described in terms familiar to the geologist.

By WILLIAM C. GUSSOW, Union Oil Company of California
Calgary, Alberta, Canada

TRADITIONALLY, TWO factors have been prerequisite to any geological search for accumulations of petroleum —source beds, and structure. They are fundamental, but it must also be realized that time is a fourth dimension of equal importance. Formation of structure must have preceded migration of hydrocarbons: obviously, those structures formed after the oil and gas have passed will be dry.

In a previous paper[1] the mechanics of petroleum migration were discussed: primary migration is controlled by compaction of the source beds due to overburden pressure; secondary migration is initiated by tilt and dependent on buoyancy. The time of formation of traps, however, dates the earliest time of any accumulation. It is the age of the structure, rather than the age of the reservoir rock that limits the time of accumulation. Stratigraphic traps, reef traps, marine shoals, and depositional draping and onlap on buried topography, are traps that occur early in the history of the reservoir rock. Traps formed below an unconformity or by differential compaction and draping, form somewhat later in the history of the reservoir rock. Structures formed by tectonic deformation may be formed, by comparison, very much later.

By purely *a priori* reasoning, based on a study of these three—compaction, tilt, and structure—the timing may be worked out without reference to the actual content of the accumulations. However, modifications in the hydrocarbons themselves, both during and after migration, give effective evidence on which to base more accurate dating.

During migration, as petroleum moves into areas of less pressure, gas is evolved from it. At the time of migration every trap contains a secondary gas cap consisting of solution gas, primary gas having been trapped in increasing quantities in the deeper parts of the basin. The size of these secondary gas caps is dependent on two physical requirements—first, the amount of oil passing the trap, and second, the height of the oil-water interface above the downdip spill point. In Figure 1, the upper diagram shows an accumulation of hydrocarbons in which the oil-water interface is at the downdip spill point. If primary gas was trapped downdip, this secondary gas cap is evolved only from the oil contained in the trap. Once filled, any more oil would move along the oil-water interface without loss of pressure, and spill updip so the gas cap would not be further enlarged. In the lower diagram, however, the oil-water interface is at a specific height (x) above the downdip spill point. In this case the gas cap continually grows as more oil passes the trap and gas is evolved with the drop in pressure.

With deeper burial, many of these gas caps disappear and a condition known as undersaturation occurs. The point when the gas cap disappears is known as the saturation or "bubble point" pressure of the reservoir. These saturation pressures are the most accurate means of determining the time of final accumulation in any specific reservoir. Care must be exercised to be sure that all primary gas has been trapped downdip, and that no gas was evolved from oil that passed by. It must be either a terminal trap or one similar to the first example illustrated

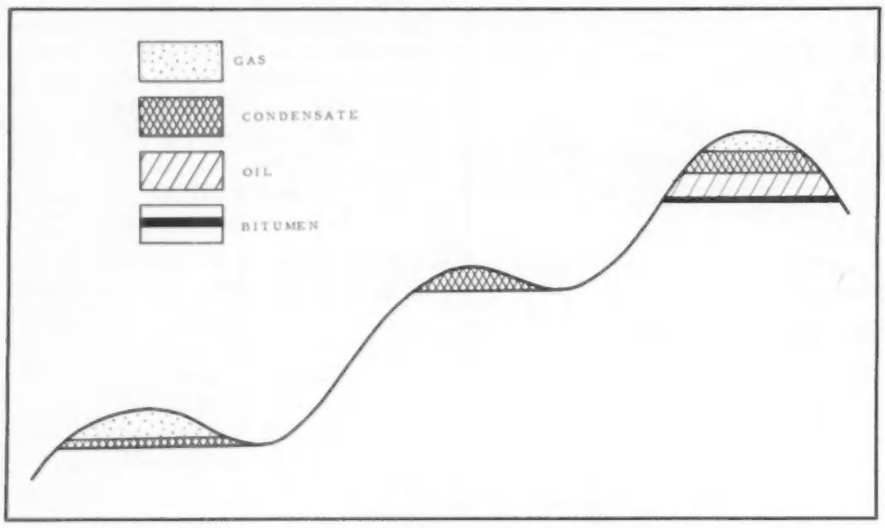


FIGURE 2—Gravity segregation.

in Figure 1, where x equals zero. The saturation pressure in such a trap corresponds very nearly to the hydrostatic pressure at the time of accumulation.

After migration has ceased the accumulations may be modified by many factors. Some of these, such as changing pressure with depth, may be used to aid in computing time of migration. Others such as seeps and hydrodynamic effects must be taken into consideration and allowance made for them in this computation. Still another is the transformation of paraffinic to cyclic oils, which is discussed as a logical conclusion from the evidence of migration and the present distribution of such oils.

Changing depth, either by deposition or by erosion at the surface has a marked influence on the gas capacity of the trap. This capacity varies directly as the pressure and inversely as the temperature, and is a function of depth. For instance, Levorsen demonstrated that the Oklahoma City field, holds 200 times the volume that it could at sea level and, since it was almost full when discovered, accumulation must have occurred when its capacity for gas was comparable to the present time. As Permian strata are exposed at the present erosion surface, Permian is the earliest time of final accumulation—it might have been even later.

Changes of pressure also have an important effect on phase relationships: the greater the pressure the more gas will go into solution, as pressure reduces gas is evolved. A similar mechanism governs the condensates in gas: the greater the pressure the richer the condensates in the gas phase. With reduction of pressure, for instance by migration updip, the condensates condense out of the gas until eventually it becomes a dry gas. Then by the simple mechanics of differential entrapment the condensates accumulate updip from the dry gas (Figure 2). Formerly, segregation of oil gravities in a reservoir was explained as the separation of the light ends by buoyancy. But miscible liquids do not separate in that way. Figure 2 shows condensate accumulating below a gas column in the lowest trap, and due to expansion of the gas, some has spilled updip into the next trap. The highest trap shows a layer of condensate beneath a gas cap and above an oil column. Due to diffusion at the oil-condensate interface, this is not as sharply delineated as illustrated but is gradational from light distillate at the top to heavy oil at the bottom. At Kettleman Hills in California, there is 68.3 API oil at the top, grading to 34.2 API at the bottom. The origin of the bitumen at the oil-water interface in Figure 2, is discussed below.

Hydrodynamic conditions generally occur in districts of topographic relief. (They tend to assist differential entrapment if present when migration is occurring.) If topographic relief is superimposed on accumulations of petroleum it is possible that the hydrodynamic gradient might flush the oil back downdip.

Seepages on the other hand are usually associated with excessive reservoir pressures. As erosion cuts down closer to an accumulation, the resulting pressure opens the fractures in the overlying rocks, permitting seepage. When the pressure has been dissipated, the fractures close (Norman Wells, N.W.T., Canada). The vertical escape of hydrocarbons at depth is much rarer than surface evidence would indicate, seeps being largely superficial. Seepages themselves are not common, migration across coarse-fine rock interfaces is impossible, while fractures and fault planes are probably tightly closed at depth.

Regional tilt superimposed on accumulations also modifies them by decantation. But regional tilt if shown in true scale cross-section is relatively slight and little spilling would occur. Regional diastrophic movements, however, might cause remigration and a new areal distribution of oil and gas fields. An example may be the gas and condensate fields in the foothills of Alberta and the Rocky Mountain States.

Finally, an analysis of the historical geology of an area taking into consideration the time of cementation, mineralization, development of secondary porosity, and unconformities, in relation to time of migration or remigration, must be carefully undertaken to reach the logical "time of migration."

In analyzing the petroleum possibilities of an area, ". . . recognize the physical essentials for oil pools, . . . but bear in mind that not alone their existence but proper timing in their development may spell out the difference between a rich oil region and one which is relatively barren."—Hedberg.

Evolution of Cyclic Hydrocarbons. Another modification of petroleum is the transformation of paraffinic oils into cyclic oils. Formerly this was explained as the effect of age or depth, but the direction of the change was in doubt, the evidence presented being inconclusive, and whether oils could be converted was a controversial question. There is a strong resemblance between coals, peat, oil shales, bituminous sands, and petroleum generally. All are believed to originate from organic matter. They are made up essentially of carbon and hydrogen in varying proportions. Most of them contain porphyrins. Some however have migrated into their present position of entrapment: others have remained *in situ*. The evidence is that the transformation may occur either

in the source bed or while migrating, or even more probably after accumulation, and it seems probable that micro-organisms which are not active in a marine environment are the effective agents.

Alfred Treibs writes, "Highly reduced compounds are produced by micro-organisms from carbohydrates, albumen, fat, with the help of fermentation processes. These may be converted into hydrocarbons by chemical or bio-chemical reaction. These fermentation processes may take on a changed direction according to the variability of the environment, and lead to less highly reduced, scarcely soluble, more solid matter. The bitumen in oil shales and cannel coal is also understood to form in this way." Might we not add cyclic oils?

Oils in some normal structural accumulations are now too viscous to move freely, and some uninspissated petroleums even approach the gravity of water. Yet their conformation in an homogenous sand and their general attitude in structure show that they must have migrated to their present location. Such for instance are the "tar belts" at the periphery of each of the major petroliferous basins —in Canada, the Athabasca bituminous sands and the Lloydminster field; in Venezuela, Qiriquire in the Maracaibo Basin and another in the Orinoco Basin; Derna in Transylvania; the Arbuckle mountains, Oklahoma; Santa Rosa, New Mexico; eastern Kansas. It is postulated that some outside agent has been effective in the transformation, and that this agent is dependent on environment.

Figure 3 is an idealized composite sketch showing the relationship and distribution of typical cyclic and paraffinic oils. In the upper part of the diagram is shown the commonest circumstance under which petroleum occurs in a marine carrier horizon surrounded by marine shales above and below. In accumulations of this type, from the deepest to the shallowest the oil is paraffinic. The Viking sands of Alberta are a fine example of this phenomenon: all Viking accumulations are paraffinic.

In the lower part of the figure, shallow accumulations are shown which are sealed at the surface by tar. These are asphaltic. However, there are also shallow accumulations held under an impervious cap rock, which are paraffinic. Accumulations at an erosional unconformity are asphaltic: an accumulation in buried topography and in sands onlapping onto the unconformity (Quiriquire) is illustrated. The term "unconformity oil" is a general expression for this type of oil and means "heavy," "black," "cyclic." Also illustrated is an example of a carrier horizon in which a downdip trap is paraffinic while the oil that has spilled up into a higher trap, near a fault, may be cyclic. The same carrier horizon in which the accumulation occurs further down on the fault might still be paraffinic, while oil spilling from this accumulation up to a trap at the unconformity is again cyclic. Deeper traps, even along a fault plane are generally paraffinic.

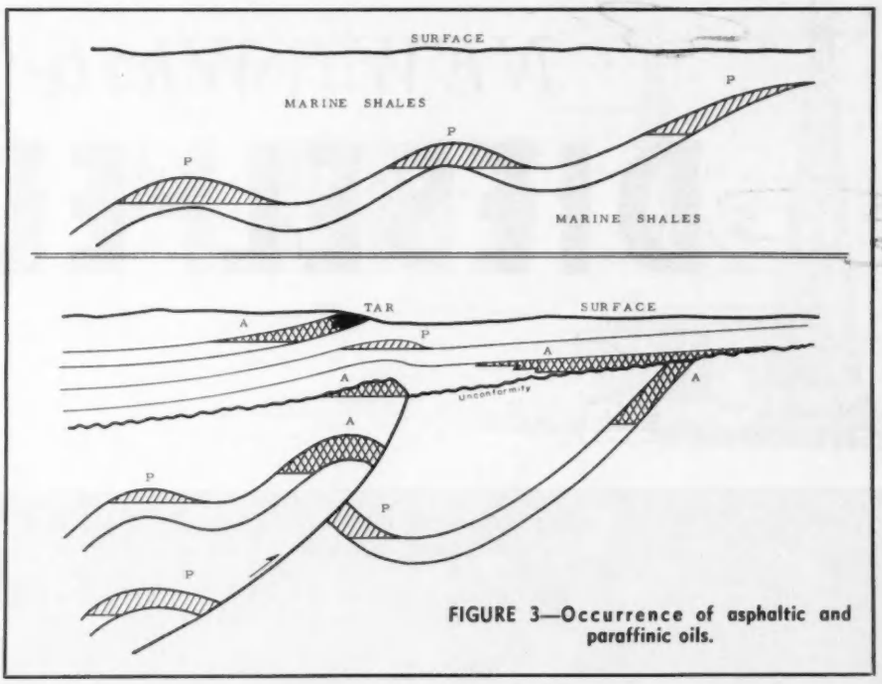


FIGURE 3—Occurrence of asphaltic and paraffinic oils.

Based on these observations of the environmental distribution of cyclic oils, it is concluded that primary oils are paraffinic and cyclic crudes are secondary. Paraffinic oils yield both mixed base oils and cyclic oils, and the end product is asphalt. This transformation of primary paraffinic crudes into secondary cyclic crudes appears to be a matter of contamination. In carrier horizons which are sealed against contamination, from the deepest to the shallowest, the petroleum remains paraffinic. However, where oils come close to an erosion surface, either the present one or an unconformity, the primary oils are altered to secondary cyclic ones.

This alteration is believed to be the result of bacterial cyclization and perhaps also polymerization by micro-organisms which have been able to exist in the form of spores at the old unconformity, and which again become active when conditions are favorable. If contamination occurs after hydrocarbons have already accumulated, a tar mat may be formed at the oil-water interface (Figure 2). Velma, Oklahoma; Hawkins, East Texas; and Burghan at Kuwait are examples of oil fields with a tar mat at the oil-water contact. Where contamination has occurred before accumulation, the connate water of the reservoir would serve to disseminate the agents of change and the whole accumulation would be relatively evenly transformed, the degree of conversion from paraffinic to cyclic type being dependent on the degree of contamination.

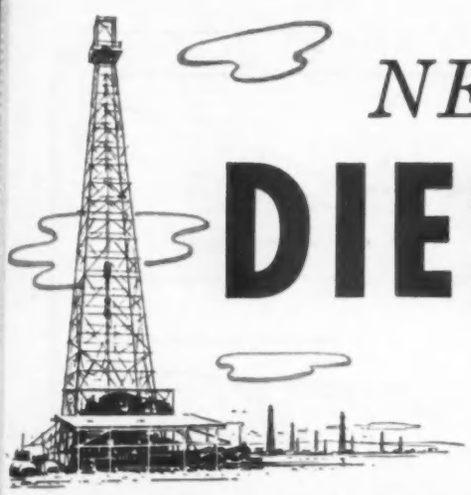
Several species of bacteria are known which are capable of converting petroleum to asphalt, others may be found. Recently Thode proved that the origin of the elemental sulfur in the Louisiana salt domes was the result of bacterial action. Asphalt frequently contains a high percentage of elemental sulfur and it is possible that these facts have a connection. This is also believed to be the origin of the trace metals in cyclic oils.

ACKNOWLEDGMENT

This article is part of a Distinguished Lecture series sponsored by the American Association of Petroleum Geologists.

REFERENCE

[1] "Migration of Oil," William C. Gussow, WORLD OIL, August, 1956.



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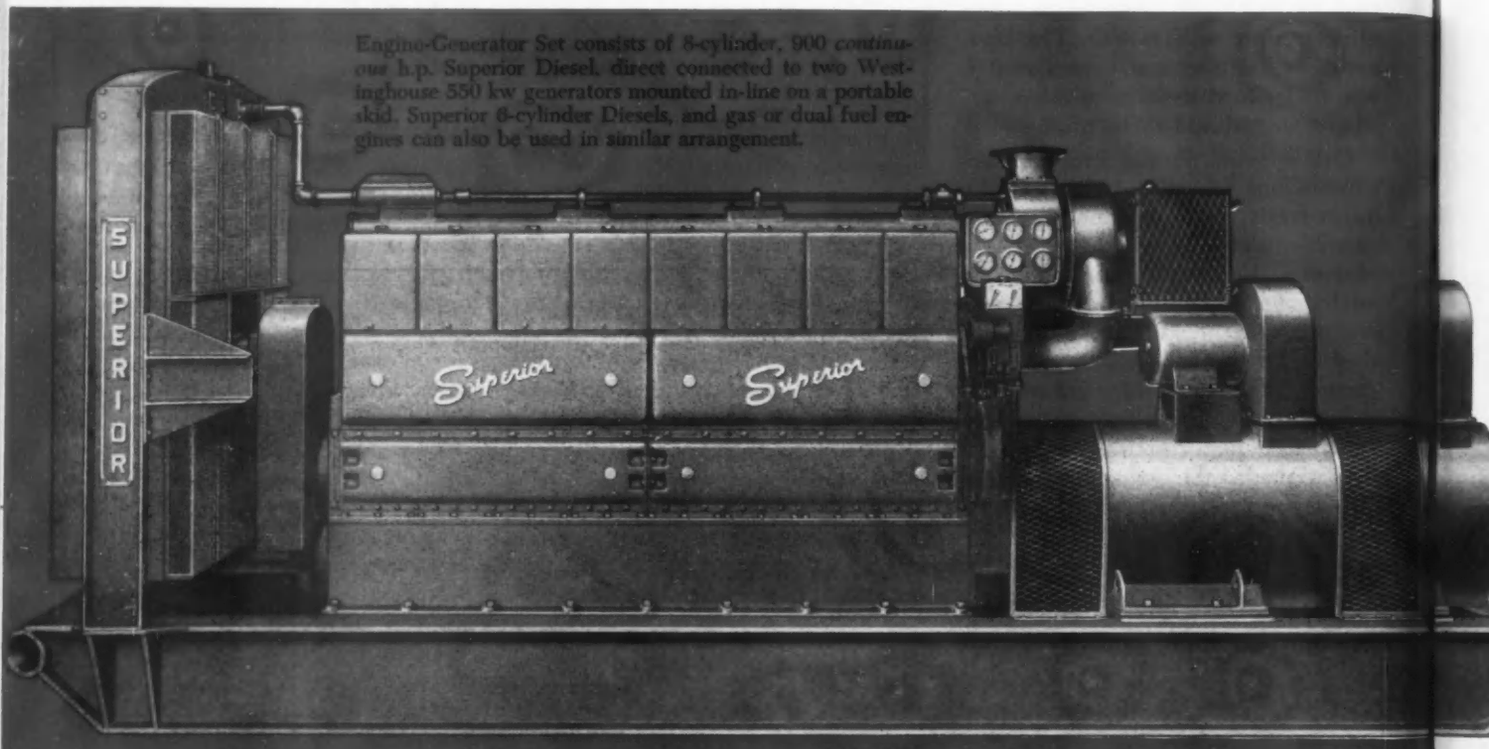

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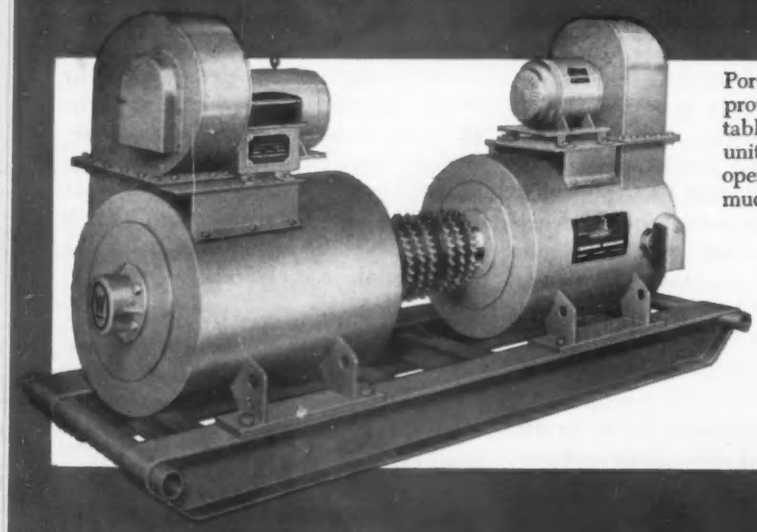

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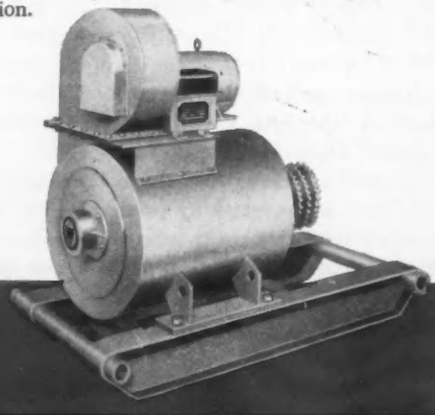

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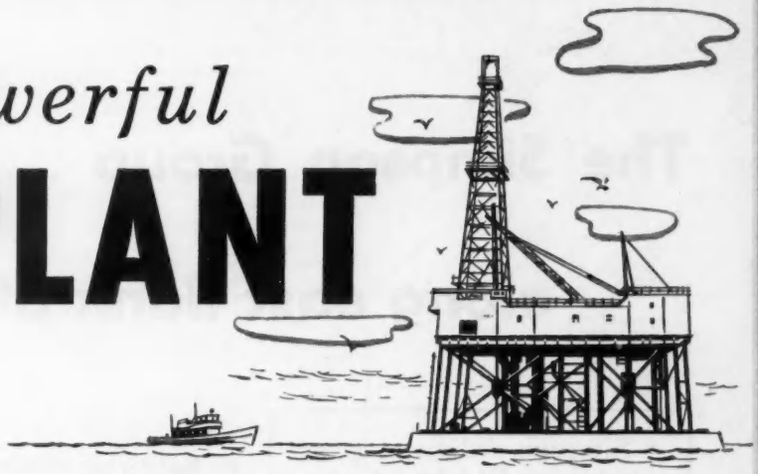

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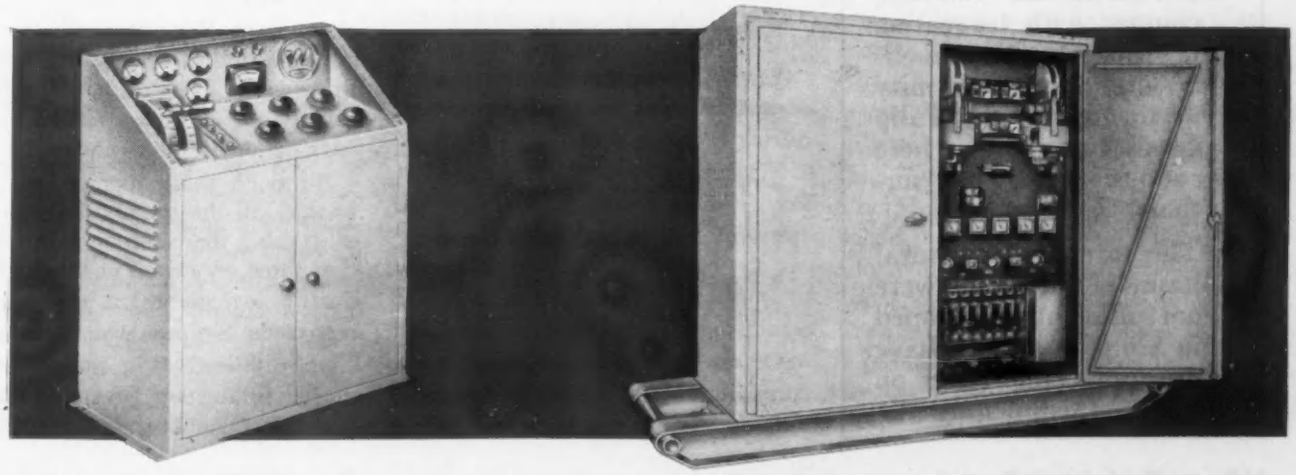

Drillers controls may be conveniently arranged in this console-type stand, or they may be grouped in any arrangement or location desired. Electrical cabinet houses all electrical devices and apparatus.

The Simpson Group . . .

along east flank of the Anadarko Basin

- **Simpson sediments over most of Oklahoma may represent those which have been deposited on a nearly stable shelf area, and are not indicative of any geosynclinal facies.**
- **The abundance and persistence of pure quartz sandstones throughout the five formations indicates not only a remarkable continuing source but perhaps a reworking of lower Simpson sandstones exposed by erosion before the end of Simpson time.**
- **Wind may have played an important part in the transportation of the Simpson sands as is evidenced by the presence of frosting and pitting on the characteristic "golf ball" sand grains.**
- **The general thinning of the Simpson northward is accomplished by onlap at the base, and interformational thinning coupled with truncation of the top. The likelihood of an unconformity at the top of the Tulip Creek formation is here recognized by the authors.**
- **The present structural basins of Oklahoma were not sufficiently developed in Simpson time to have an appreciable effect on Simpson sedimentation.**

By RALPH W. DISNEY and CHARLES E. CRONENWETT
University of Oklahoma, Norman, Okla.

THE SIMPSON strata as seen in Oklahoma is quite unique and reflects certain pecularities. Originally, the formation was deposited in shallow marine waters on a slowly sinking shelf area known as the Oklahoma basin. This area was part of the embayment of the larger Ouachita geosyncline. Throughout Simpson time this shelf was essentially stable. Slight movements, however, caused numerous minor transgressions and regressions of the Simpson seas.

The sandstones of the Simpson group are relatively pure, being composed almost entirely of quartz and represent multicycle sediments. These sediments were in part subjected to wind action prior to their final deposition.

Thinning of Simpson units can be attributed to one, or a combination of the following geological processes:

- Onlap on the base.
- Truncation at the top.
- Intraformational and interformational unconformities.
- Depositional thinning.

Important unconformaties possibly associated with cratonal movements during Simpson are:

- Post-Arbuckle pre Joins.
- Post-Tulip Creek pre-Bromide.
- Post-Bromide (Simpson Dense) pre-Viola.

On the basis of regional subsurface correlations only, which undoubtedly imposes certain stratigraphic limitations, the following correlations are made tentatively:

1. The Burgen sandstone of northeastern Oklahoma is correlative with the basal Oil Creek sandstone.

2. The Tyner formation of northeastern Oklahoma is correlative with the lower McLish formation and possibly the upper Oil Creek formation.

3. The Fite limestone of northeastern Oklahoma is correlative with either the upper Viola (Trenton) which rests immediately above the post-Bromide pre-Viola unconformity, or, it is a McLish limestone, lying immediately below this same unconformity.

4. The Seminole sand is Viola in age and represents a facies condition within the Viola.

For many years the stratigraphy of the Simpson group, especially in the subsurface, has been an enigma to geologists working with it. This has been due to several reasons, foremost of which has been the general lack of adequate subsurface information, which has hindered study on a regional basis. The effect of many workers reporting on local areas, without studying regional relationships, has resulted in some misuse and a general haziness of Simpson nomenclature.

Although this paper by no means resolves all the unanswered questions concerning the Simpson formations it does show, by means of lithologic and electric log studies, a regional concept of the Simpson which the authors hope will lead to a more complete understanding of Simpson stratigraphy in Oklahoma.

To obtain an over-all picture of the Simpson in east central Oklahoma, an electric log cross section was constructed which extends from the northwestern Arbuckle Mountains northward along the east flank of the Anadarko basin approximately to the Kansas state line.

A second cross section was constructed which extends eastward at right angles to the first, across central Oklahoma to near the Arkansas border.

Studies of these sections, together with examination of samples from many wells are used on the cross sections, provided most of the data used in preparing this report. Several times during the course of this work stratigraphic relations in the field were also studied.

The Simpson group was first recognized and named by Taff (1902), and since that time the history of the study of the Simpson group has been an interesting one, with many workers contributing significant observations. In 1931, Decker, in his comprehensive report on the Simpson in the Arbuckle Mountains, recognized five divisions and raised the Simpson to the rank of a group. In this article, the authors will use his terminology.

A complete section in south central Oklahoma listed in order of deposition includes the following formations: Joins, Oil Creek, McLish Tulip Creek and Bromide. Within the area studied the total thickness of these formations ranges from 2025 feet to the south, to about 200 feet near Tahlequah, Okla. Along the east flank of the Anadarko basin these formations are predominantly clastic, but contain numerous intercalated thin limestones and dolomites. These nonclastic, with few exceptions, yield a high insoluble residue which is for the most part, composed of quartz grains. The typical green waxy shales, and almost monomineralic composition of the sandstones are well known and will not be dealt with here.

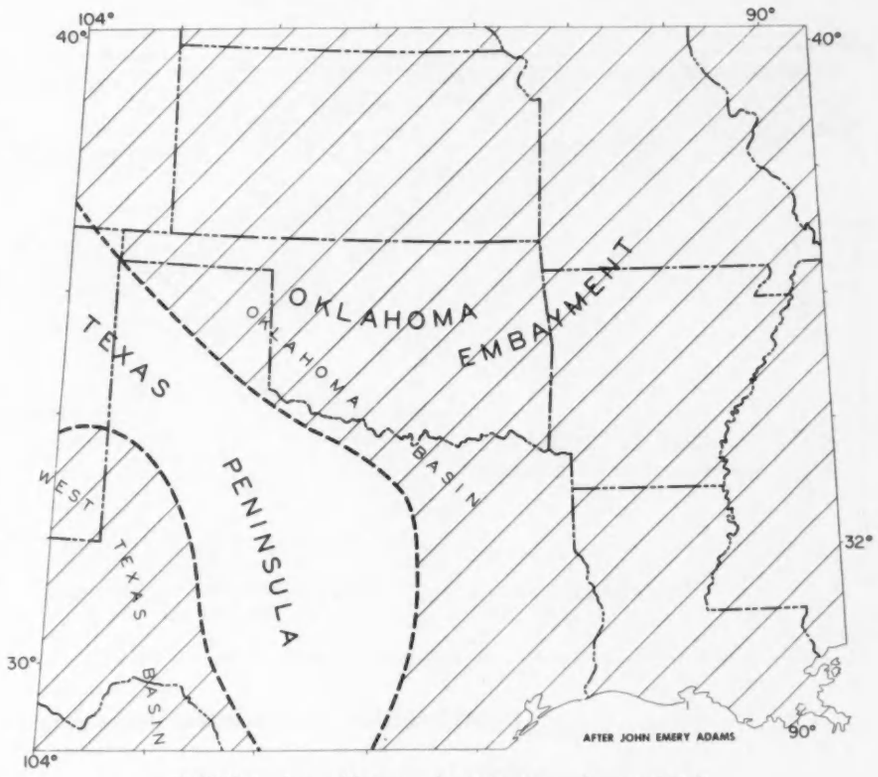

FIGURE 1—Area of Simpson deposition in south central U. S.

Depositional History. The distribution of Simpson and equivalent sediments in the states surrounding Oklahoma is shown in Figure 1. This map is a modification from John Emery Adams (1954), and shows a portion of the immense area covered by these middle Ordivician sediments. (Southeast Texas and Louisiana are questionable areas of Simpson deposition). Lithologic equivalents (St. Peter, etc.) are also present in Iowa, Wisconsin, Minnesota, Michigan, Illinois, and Indiana as well as time equivalents in both the Appalachian and Corridilleran regions.

The Oklahoma basin is believed to be a portion of an embayment which projected northward into the state at the time Simpson deposition. This in turn is a part of the cratonal shelf area of the larger Ouachita geosyncline that persisted throughout most of Paleozoic time. From this one can see that to label the basin in which the Simpson of Oklahoma was deposited as the Anadarko basin, is a misnomer.

Reference to the isochore map of the undifferentiated Simpson group (Figure 2) contrasted with the structural contour map on top of the Arbuckle group (Figure 3) clearly shows that the two basins had little more than a general geographic location in common.

Also, we can find no evidence that the Anadarko basin of today existed prior to Pennsylvanian time. The apparent basinward thickening of the Simpson to the southwest would be considerably lessened if the Simpson strata lost through erosion during post-Bromide pre-Viola time could be restored.

Regional Correlations. As mentioned previously, these correlations have been taken from a combination study of electric logs and well samples. The authors' original correlations are based on surface exposures of the Simpson in the Camp Classen area, four miles southwest of the town of Davis, Okla., in Murray County. This area was the location of a field study by Dunham (1951), which included detailed work on the Simpson group and was chosen as a starting point for the north-south cross-section due to its proximity to wells which penetrated full sections of Simpson in the subsurface.

Using the original divisions of Decker, it was found that the formations could be broken down into smaller units to enable more accurate correlations. This was done as follows: the Joins formation was not subdivided, the Oil Creek was divided into a basal sandstone, and an upper shale and limestone unit. For this paper the McLish was considered as a complete unit, but the Tulip Creek was divided into a basal sandstone and an upper shale unit. The Bromide was separated into three units: a basal sandstone which is overlain by a sandy dolomite (the Marshall zone of North-central Oklahoma), and a dense lime-

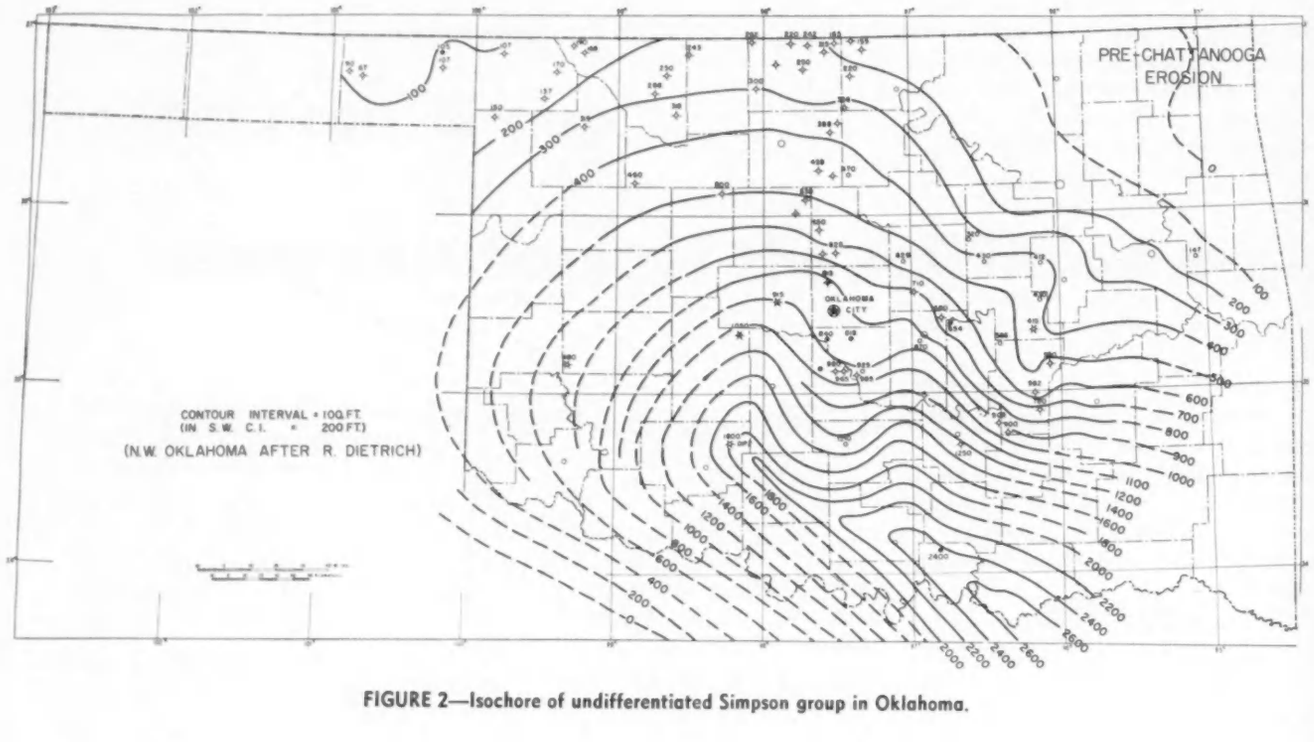

FIGURE 2—Isochore of undifferentiated Simpson group in Oklahoma.

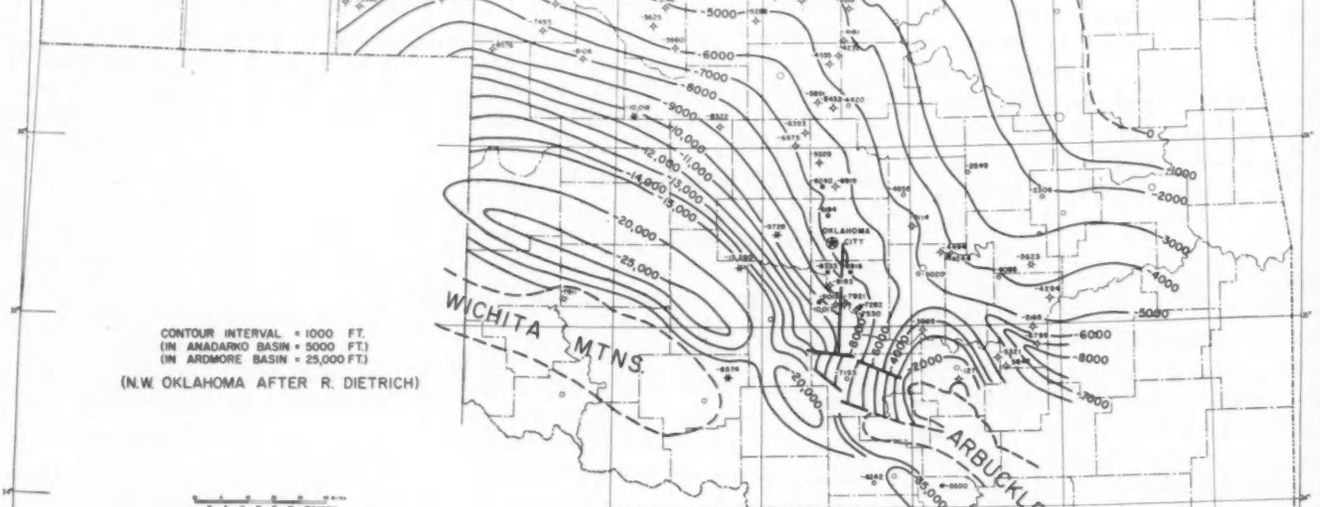
CONTOUR INTERVAL = 1000 FT.
(IN ANADARKO BASIN = 5000 FT.)
(IN ARDMORE BASIN = 25,000 FT.)
(N.W. OKLAHOMA AFTER R. DIETRICH)
WICHITA MTNS.
ARBUCKLE MTNS.
OKLAHOMA CITY

FIGURE 3—Structure contour map on top of Arbuckle limestone.

stone, the Simpson Dense of the oil fields.

The following discussion of the stratigraphic relationships of these formations as they thin northward across Oklahoma has been derived chiefly from Figure 4. All pre-Bromide formations decrease in thickness toward the north due to a combination of progressive onlap at the base and to a thinning within the units. The Joins formation, as well as the Oil Creek sandstone, however, disappear entirely in this direction. The former is not present beyond T16N R3W, while the Oil Creek sandstone is last recognized at its "feather edge" in T17N R3W. The Tulip Creek sandstone also is greatly attenuated and cannot be traced with certainty beyond T23N, R3W.

An investigation of the post-Tulip Creek units shows that they have been truncated at the top by pre-Viola (Trenton) erosion. An evidence of this is the absence of the Simpson Dense limestone north of T15N, R2W. Farther to the north and east the post-Hunton pre-Chattanooga unconformity also cuts down into Simpson strata.

At this time it becomes necessary to examine more closely the relation-

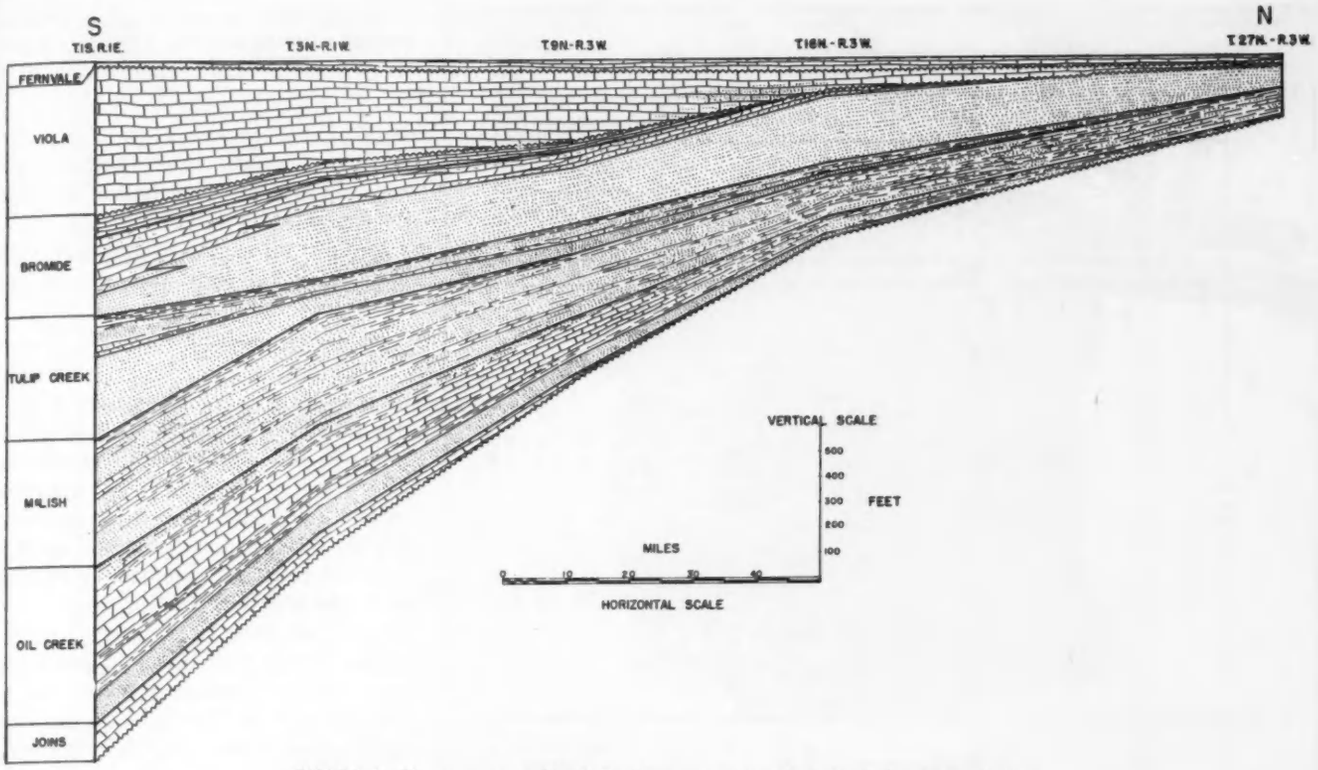

FIGURE 4—Simpson group. North-South cross-section. East flank Anadarko Basin.

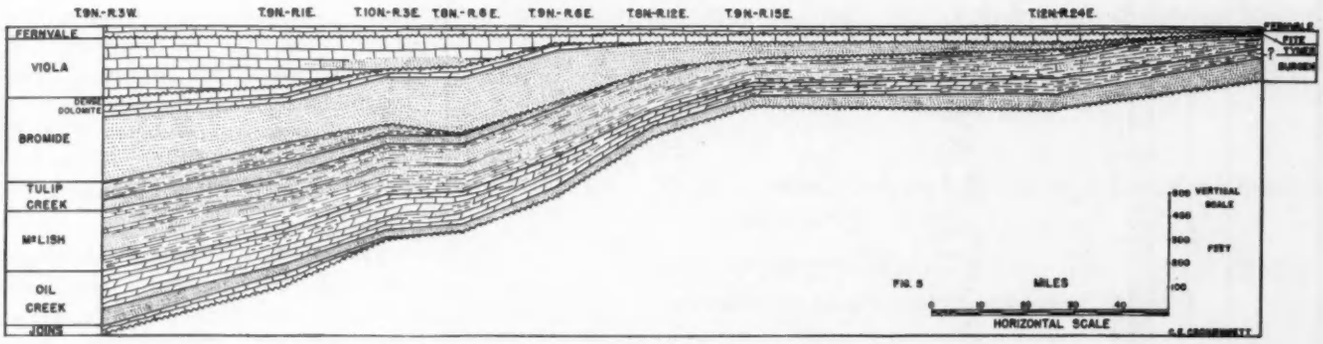

FIGURE 5—Simpson group. East-West cross-section. Cleveland to Cherokee County.

ship of the Simpson-Viola contact for the authors believe this is to be an important key to the correlation of Simpson strata.

As mentioned above, the Bromide sandstone or Second Wilcox sandstone, is overlain by a transitional sandy dolomite zone. This zone has been called the Marshall zone in recent years, and is known to thin over areas where the Bromide sandstone is structurally high. Overlying and apparently transitional with this zone is a light brown to tan microcrystalline dense limestone. The top of this limestone is recognized by most geologists and the writers as the upper limit of the Simpson group. Although the base of this limestone seems to be transitional with the underlying Marshall zone, it is not unlikely that an unconformity separating these units will be recognized.

Over a broad area the eroded top of the Simpson is onlapped by the Viola limestone, which suggests that some movement may have taken place in the northeastern Oklahoma area during the interval of post-Simpson pre-late Viola (late Trenton) time. As noted above, the position of the Viola (Trenton) resting on the Bromide (Second Wilcox) sandstone seems to substantiate this.

Next let us examine the relationships of the Simpson strata to the east (Figure 5). This cross section ties on to the north-south line of section at T9N, R3W, and extends to R24E.

Considering first the pre-Tulip Creek formations, they can be seen to thin slowly eastward to about R15E. From this point the basal oil Creek sandstone begins to thicken somewhat while the lower McLish sandstone units coalesce and form one thick basal sandstone unit.

An examination of the Tulip Creek formation indicates that in T10N, R2E, the upper shale unit begins to thin rapidly to the east. Beyond R6E this unit is missing, and the Tulip Creek sandstone begins to lose thickness noticeably. As this horizon is traced farther toward the east, it is found that the basal Bromide sandstone onlaps successively lower mem-

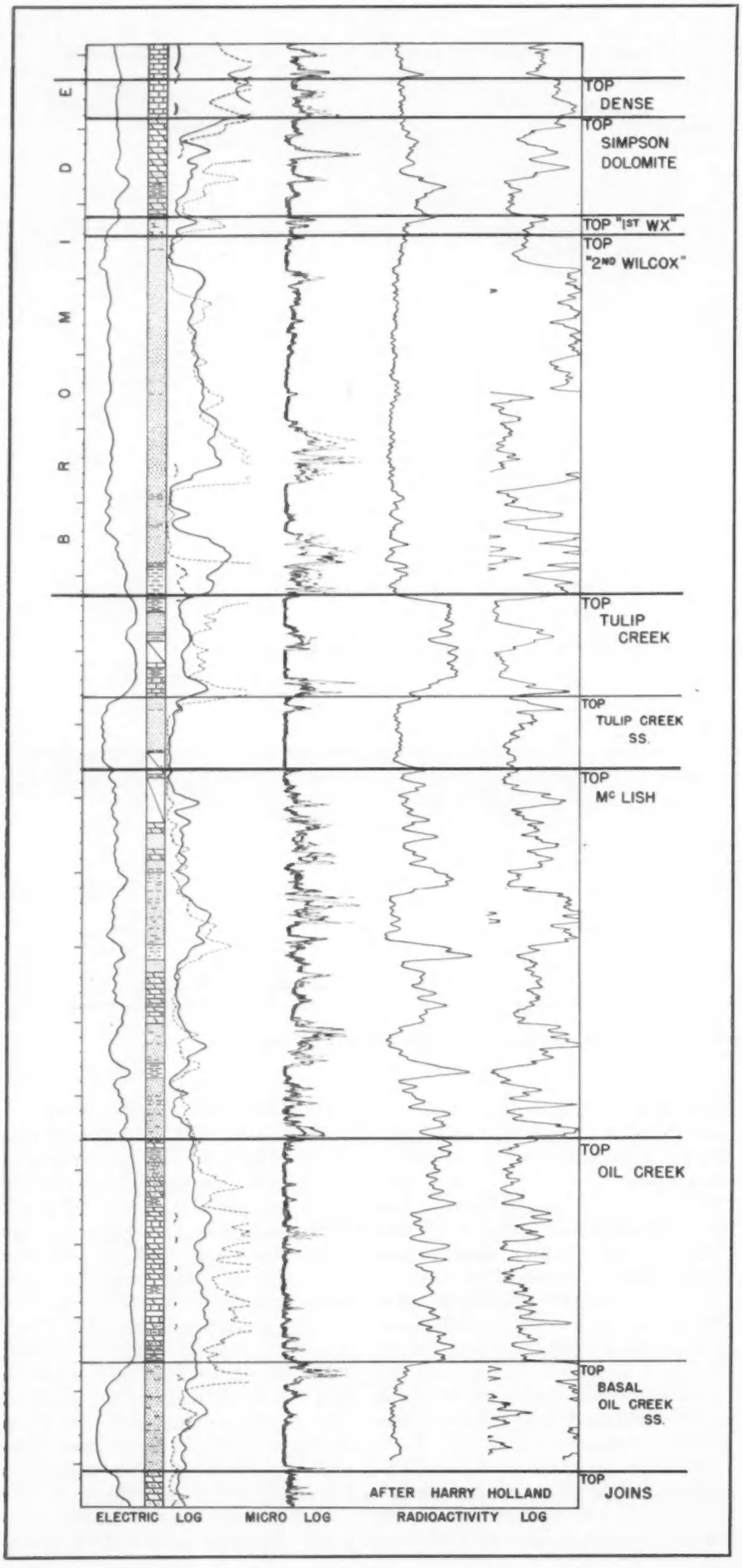

FIGURE 6—Type Simpson group log diagrams. Producers Development No. 1 Harris. SW NW NE Sec. 29 T9N, R3W.

bers of the Simpson until in T9N, R9E, in the vicinity of Okemah, approximately the upper half of the McLish formation has been truncated. This uncomfortable relation of the Tulip Creek is not apparent to the west.

As an explanation for this it is suggested that the ancestral Ozark mountains underwent a slight pulsation near the end of Tulip Creek time which affected only northeastern Oklahoma. The resulting unconformity does not extend any farther west than approximately R3E. Later, at the end of Bromide deposition, another pulsation occurred which affected a more extensive area. This later movement resulted in the post-Bromide pre-Viola unconformity previously mentioned in connection with Figure 4, and is even more pronounced in the east-west cross-section. In an easterly direction the Simpson Dense thins and disappears by T10N, R3E. The underlying Marshall zone then becomes exposed and is lost through truncation by about R16E. From here eastward the post-Bromide pre-Viola unconformity slowly cuts down through the Bromide sandstone and between R16E and Tahlequah, T17N, R22E converges with the unconformity at the base of the Bromide.

The Viola (Trenton) along this east-west line of section consists of coarsely crystalline white limestone and dolomite, together with finely crystalline to dense limestones. Locally it may develop sandstone horizons such as in the Seminole area where 55 feet of sandstone occur. This sandstone has been variously called the First Wilcox or Seminole sand. The latter name is preferred by the writers, since the stratigraphic relations clearly indicate that it is a part of the Viola rather than a local development of the Simpson (Figure 6). The source of these sandstones was possibly derived from Simpson strata which were exposed to erosion in the ancestral Ozark mountains of northeastern Oklahoma during early Trenton time.

The authors believe, on the basis of regional subsurface correlations, that the Burgen sandstone of northeastern Oklahoma is equivalent to the basal oil Creek sandstone, and the

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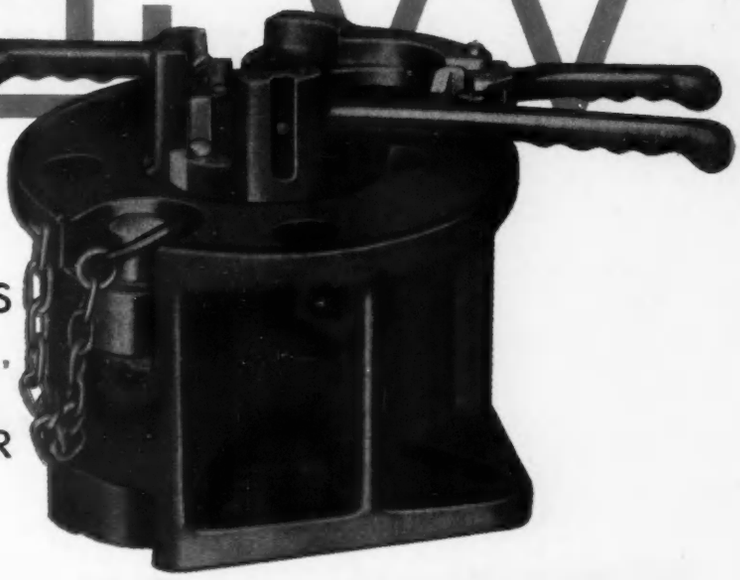

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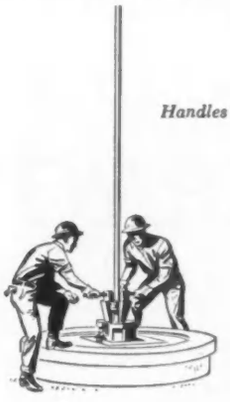

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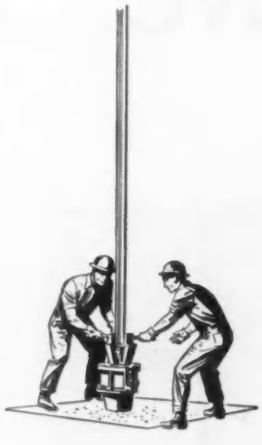

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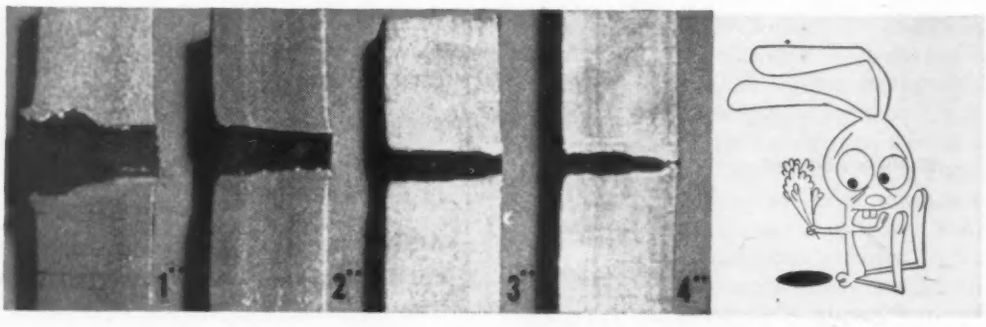

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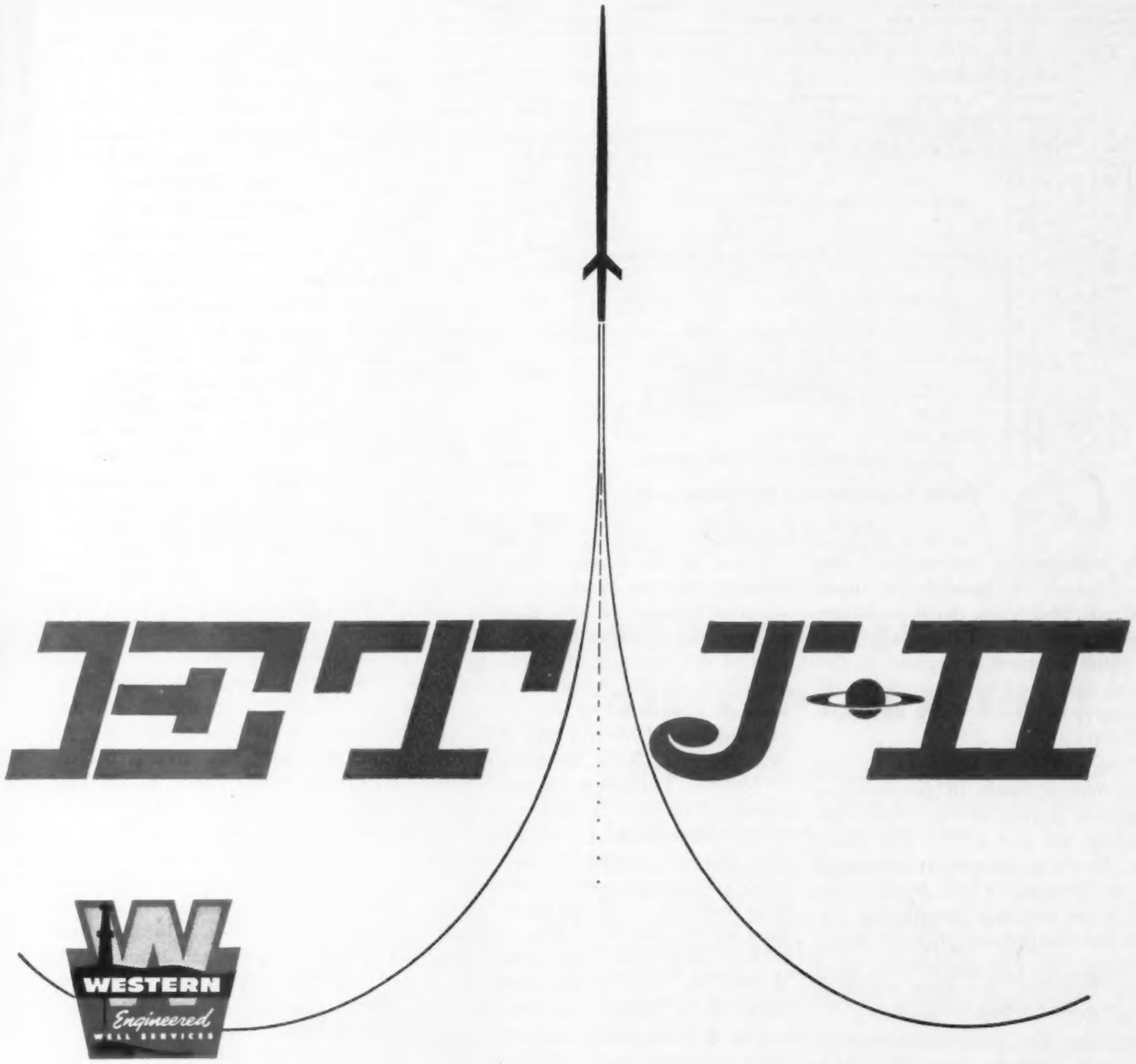

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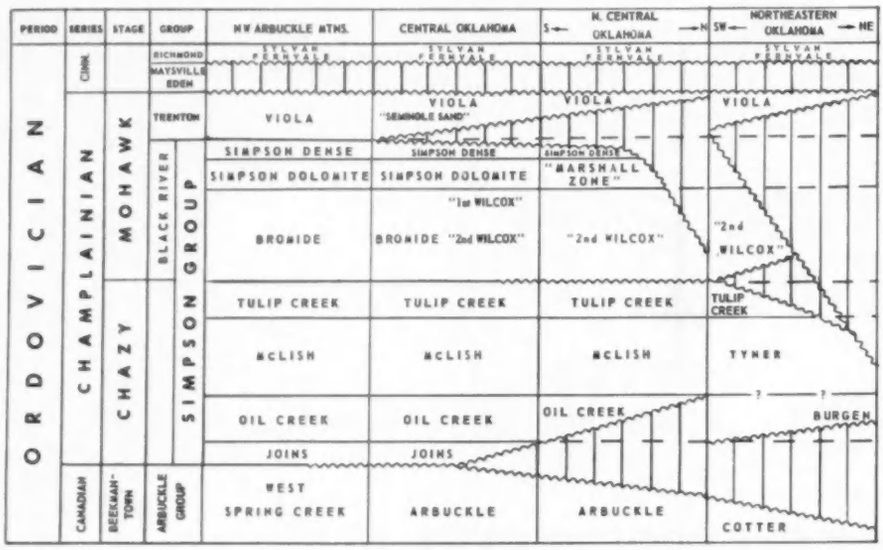

FIGURE 7—Correlation of the Simpson group.

Tyner formation is equivalent to the lower McLish and possibly the upper Oil Creek. If a Viola dense limestone extends into the Tahlequah area where the Simpson is exposed at the surface, then the Fite limestone would be equivalent to the Viola limestone (Trenton).

White (1926) in his work on the upper Wilcox sands in northeastern Oklahoma arrived at this conclusion regarding the age of the Fite limestone. However, in view of the rapid rate of thinning of the Viola limestone to the east, it is possible that the Viola has disappeared through onlap rendering the Fite equivalent to a dense, "birdseye" limestone, which is typical of the McLish formation.

Overlying the Viola (Trenton) in all cases is a coarsely crystalline black and white mottled limestone which has long been assigned to the Fernvale.

The parallelism of this interpretation along the east flank of the Anadarko basin and the northeastern Oklahoma surface is striking. It postulates that the geological conditions were nearly identical in the two areas, the only difference being a matter of the degree of erosion. In north central Oklahoma, the deepest post-Simpson Dense, pre-Viola erosion cut only into the Second Wilcox or Bromide sandstone, but in north eastern Oklahoma this same erosion cut deep into the McLish formation, indicating the more positive nature of the ancestral Ozark Mountains in this area.

Since this work was accomplished through the use of electric logs and the examination of well samples, let us turn our attention to a typical section of the Simpson group along the east flank of the Anadarko basin as seen in Figure 6, in the Producers Development Harris, 1 SW NW NE, Sec. 29, T9N, R3W, three miles west of Norman. It opened the way for the discovery of the Northwest Norman field, which found production in all the Simpson sandstones as well as other younger productive horizons. In this well the total thickness of the Simpson is 1066 feet. The Joins formation was not completely penetrated, but other wells nearby have supplied the missing information.

The Joins is predominantely a limestone, approximately 118 feet thick, with no sandstone development, and it directly underlies the basal Oil Creek sandstone. This sandstone has a thickness of 75 feet and is a continuous sand body except for several thin limestone horizons and numerous thin green to black shale partings. It was originally called the Joins sandstone by pioneering geologists of this area on the basis of graptolite determinations by Dr. C. E. Decker of the University of Oklahoma. Later correlations have proved the top of the Joins to be immediately below the base of this sandstone.

Above the basal Oil Creek sandstone is a 152-foot section of predominately shaly limestone, and thin horizons of typical Simpson green, waxy shale. Several sandy limestones and sandstone lentils occur in this interval, but they are not persistent. This section we have referred to as the upper Oil Creek.

The McLish formation comprises 248 feet of predominantly clastics with interfingering dolomites. The McLish interval appears to have been a time of accelerated transgressing and regressing seas. It can be roughly divided into 3 zones; upper, middle and basal sandstones, although the sand bodies are gradational both vertically and laterally, and are not clean sandstone such as the Oil Creek.

The Tulip Creek is divided into the basal Tulip Creek sandstone and the upper Tulip Creek shale, and is 125 feet thick in this well. The basal Tulip Creek sandstone has been termed the Third Bromide sandstone by geologists working in southern Oklahoma. The upper Tulip Creek contains the typical Simpson green shale which is often divided by a 20-foot, usually hard and dolomitic, sandstone.

The Bromide sandstone is a thick (256 feet), continuous sand body, often referred to as the First Wilcox and Second Wilcox sandstones. The First Wilcox of this area is not correlative with the First Wilcox sandstone of the Seminole district or of northern Oklahoma. In this well, the sandstone is found immediately above the Second Wilcox and is identified and differentiated from the Second Wilcox on the basis of lithology only. The First Wilcox sandstone in this well is 13 feet thick, and is composed almost entirely of coarse, frosted quartz grains. Near the base of the Second Wilcox sandstone a re-entrant feature of the resistivity curves on electric logs is quite characteristic and offers a good correlating horizon.

In samples or cores, this section seems to be a cleaner, coarser, and more porous sandstone than the zones both immediately above and below. This re-entrant characteristic was used on the northsouth cross section to establish the fact that the thinning of the Bromide is by truncation at the top.

Above the Bromide sandstone is a 65-foot section of dolomitic limestone, that becomes sandy at its base and grades downward into the first wilcox sandstone. This horizon is called the Simpson Dolomite apparently because of its coarsely crystalline texture rather than because of its dolomite content. This section studies indicate that the

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Simpson Dolomite is primarily a calcarenite or calcirudite.

The abundance of "golf ball" sand grains and mechanically deposited calcite crystals, crinoid and cystoid fragments, indicates that the entire section is reworked. Above the Dolomite is the Simpson Dense limestone. The Dense is 27 feet thick in this section, and is overlain uncomformably by the Viola limestone.

Lithologic conditions similar to these described above may be expected along the southeast rim of the basin. Farther north, along the northeast flank of the basin, the lower sandstones are either poorly developed or are extremely thinned, hense are much less promising for oil production. Some stratigraphic conditions favorable to the accumulation of petroleum are present, but in the main, production from the lower Simpson probably will be controlled by structural conditions.

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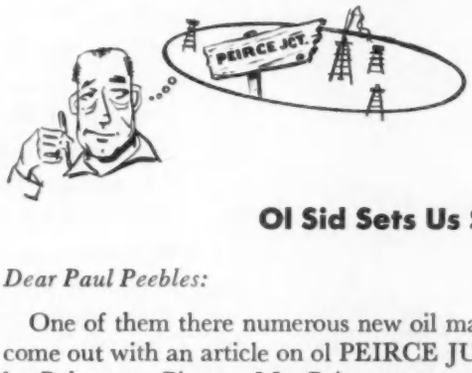
ACKNOWLEDGMENT

The authors wish to thank Harry Holland, independent geologist in Norman, Okla., who furnished valuable logs and detailed descriptions of the Simpson. George G. Huffman, William E. Ham and William McBee, Jr., are credited for their field guidance in the Arbuckle Mountains. This paper was presented at the Fourth Symposium on Subsurface Geology held at the University of Oklahoma in 1955.



Ol Sid Sets Us Strait

Dear Paul Peebles:

One of them there numerous new oil magazines called WORLD OIL has come out with an article on ol PEIRCE JUNCTION (note that it should be *Peirce* not Pierce—Mr. Peirce was an early day railroad builder and the junction was named after him). Well to quit ramblin and git back to this petroleum industry as its called nowadays. This article says "Information on the early history of the field is scanty." Yep, scanty as Cleo's picnic drawers if you remember them. — Gittin back to business again. — What the hell do these modern oil reporters — scuses — editors do to earn their sirloins and ice cream? Can they be induced to lift their rumps from the foam rubber pads of their office chairs and take a short walk down the air-conditioned corridor of the palatial editorial section to the library where perhaps several columes of the ole reliable *Oil Weekly* (now WORLD OIL) probably be buried in the dust and pick up the issue of December 2, 1927, wherein there is an article at pages 95 to 98 on the early history of the field by Wayne Bowman (I bet that old codger ain't got a tooth left in his head).

But why argue about history—the good old days are—tomorrow!

Yours with aches and pains,
Sidney Strong

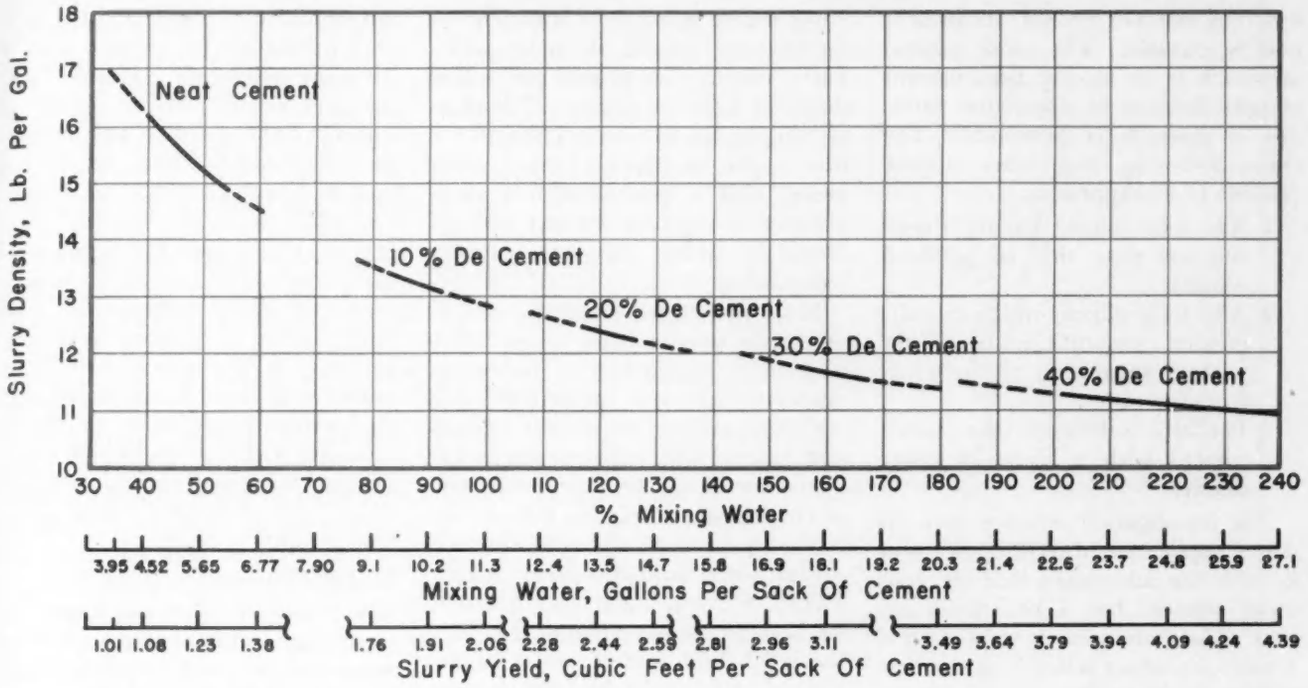


FIGURE 1—Slurry density as a function of water concentration for DE cement systems. Generally recommended water content shown by solid lines.

Low Density Oil Well Cements

Pressure insensitive densities ranging from 10.5 pounds per gallon to neat cement can be obtained with reduced strength and modified thickening time.

By F. J. SHELL, J. R. HURLEY, W. E. BERGMAN and H. B. FISHER
Phillips Petroleum Company
Bartlesville, Oklahoma

OIL WELL CEMENT research by Phillips Petroleum Company has resulted in the development of a new low density cement. Cement slurries having densities as low as 10.5 pounds per gallon have been made by adding water to mixtures of a special grade of diatomaceous earth (DE) and common portland cement. This special grade of diatomaceous earth has been described in previous reports.[4, 8, 9] These papers are primarily concerned with cement systems having low water-loss characteristics, that is, with cement systems of varying density containing carboxymethyl hydroxyethyl cellulose (CMHEC). The present article will present technical data gathered to date on low density DE cements.

The advantages of low density cement are well known and will not be elaborated upon except to note that a cement density closely approximating the mud density is desirable. Presently, reduction in cement slurry weight is accompanied by a decrease in set strength or by an increase in cost or both. In the case of DE cements, the low slurry density is achieved at a sacrifice in strength. Two bonus values exist; (1) the density reduction is accompanied by reduced material cost, and (2) the density of the slurries does not increase with pressure.

EXPERIMENTAL

A. Materials

Cement: Common portland cement (API Class A or ASTM Type I.[1])

DE: A special grade of diatomaceous earth was used.

Calcium Chloride: A chemically pure, anhydrous material was used.

B. Test Procedure

Portland cement was blended for 35 seconds with other dry ingredients prior to mixing with the desired amount of water. The concentration of the various ingredients is expressed as "percent," which in cement terminology means parts by weight per 100 parts of cement rather than percent by weight of the mixture. Details of some of the special equipment and procedures are described in API RP 10B.[2] The equipment has been improved to permit automatic control and recording of temperature. These improvements are described briefly by Bergman et al.[4]

RESULTS AND DISCUSSION

A. General

There are several approaches to the problem of preparing oil well cements with densities lower than can be accomplished with neat cement slurries. For example, there could be a complete substitution of the water-portland cement system with a low density plastic material of controllable setting time. While this type of sys-

tem can not be ignored, its present cost is excessive. The more general approach is to modify neat cement slurries, bearing in mind that sacrifice in strength is permissible. The three following techniques appear possible in this approach.

1. Add solid diluent having a density less than that of portland cement.
2. Add solid diluent which permits greater proportions of water without separation of the solids from the water.
3. Partially substitute the water present with a liquid of lower density.

The investigation reported here involves application of techniques 1 and 2, with the advantage that the material selected has a pozzolanic action.[7] The diatomaceous earth used is a special product selected as the best diatomaceous earth available for reducing the density of cement slurries. Screening was carried out by determining the amount of separation of solids as a function of the volume of water added to a mixture of 40 percent diatomite in Class A cement.

With diatomaceous earth as a diluent, a decrease in slurry density is accomplished partly by the lower density of the diatomite compared to the portland cement (2.1 versus 3.15 gm/ml) and mainly by the large amount of water that can be added to a slurry without permitting separation of solids. This dilution of the portland cement slurry causes some increase in thickening time and a decrease in set strength.

A limiting factor in the application of DE cements or other cements is the strength required for successful cementing in a well. The minimum strength requirement is a controversial problem. Farris[6] has shown that 8 psi tensile strength is sufficient to support the casing in most wells. Farris used a 15.6 pounds per gallon slurry of Class A cement. The ratio of compressive to tensile strength for this system is about 12 to 1. This means that a cement with a compressive strength of around 100 psi should be strong enough to support most casing.

Since such small strengths are required the question then arises, "Why is strength considered an important property for well cements?" The complete answer requires a discussion beyond the scope of this report but a few of the simplest points will be considered. Clark[5] has shown a relationship between strength and fluid shutoff for a limited number of conditions. He concluded that a tensile strength of 50 psi or higher is needed for good fluid shutoff. This conclusion is valid only for the systems studied by Clark since permeability and hence water shutoff vary for different well cements.

The minimum strength necessary for an oil well cement is dependent upon the cementing operation. For example, the strength requirement of cement behind 7000 feet of casing cemented from shoe to surface would be less than that required if the same casing string were to be cemented with only 500 feet of cement around the bottom. It is believed, therefore, no categorical strength requirement should be set for all jobs. It is cheaper and more efficient to tailor cement for the job.

The desirability of using a density reducing diluent that has pozzolanic action is worthy of a few comments. This attribute is considered particularly desirable when the material used absorbs large amounts of water. Chemically, pozzolans decrease the susceptibility of cement to dissolution or deterioration by reaction with the calcium hydroxide released when portland cement sets. Reactive substances of the pozzolan are converted by this reaction into stable compounds, many of which are cementitious. Mielenz et al[7] state that pozzolans of activity type II (diatomaceous earth and chert) are the most active of all natural pozzolans. The pozzolanic action of diatomaceous earth produces a gel which is relatively non-cementitious in its early stage. The cementitious value of this gel increases with age and temperature.[10] By combining with lime, diatomite reduces the permeability and sulfate susceptibility of cement.

TABLE 1
Thickening Times of Slurries Containing Class A Cement, DE and Varying Amounts of Water

Water, Percent	DENSITY, LB./GAL.		15 Min., Viscosity, Poise	THICKENNG TIME, Hr.: Min.				
				Temperature		Super-Pressure		
	Calculated	Measured		80-110 °F	80-180 °F	800′	10,000′	12,000′
Part A: 40 Percent DE:								
240	10.85	10.7	10	12.32	6:36	8:30	3:50	2:30
230	10.95	.....	10	11:00	1:43	.....	.....	.....
220	11.05	10.95	11	9:38	1:32	8:30	2:58	1:18
210	11.15	.....	15	1:45	1:28	.....	.....	.....
200	11.26	11.2	18	1:40	1:25	1:27	1:12	.....
190	11.38	.....	20	1:33	1:21	.....	.....	.....
180	11.52	11.5	22	1:26	1:18	1:24	1:07	.....
Part B: 20 Percent DE:								
140	11.95	11.9	10	.....	.....	1:38	.....	1:23
130	12.14	12.1	12	.....	.....	1:36	.....	1:22
120	12.39	12.3	18	.....	.....	1:34	.....	.....
110	12.62	12.6	21	.....	.....	1:32	.....	.....
Part C: No. DE:								
46	15.7	.....	..	1:37	1:37	.....	.....	.....
54	15.0	.....	..	1:56	1:56	2:22	.....	.....

B. DE Cements

1. *Water to Cement Ratio:* The maximum and minimum water to cement ratios for slurries containing 10, 20, and 40 percent DE were determined. Minimum water is defined as the least amount which can be used without exceeding an initial consistency of 30 poises on a consistometer. Maximum water is the largest amount which can be used without causing separation of water after the slurry has set for 3 hours. The ranges of water content for slurries containing 10, 20, and 40 percent DE are 80 to 110, 110 to 140, and 170 to 290 percent, respectively. A plot of slurry density as a function of water content is shown in Figure 1. Included in this figure is a curve showing the variation of density with water content of neat cement slurries.

The density of DE cement slurries, especially in the low density range, is much nearer the density of water than that of the neat cement slurries. Hence the same change in water concentration causes a much smaller change in density. To illustrate this, consider the following examples involving a 10 percent change in water content. With a neat cement slurry, increasing the water content from 60 to 70 percent changes the slurry density 0.6 pound per gallon from 14.6 to 14 pounds per gallon. With 40 percent DE cement slurry, increase in water content from 230 to 240 percent changes the density only 0.1 pound per gallon from 10.9 to 10.8 pounds per gallon.

2. *Thickening Time:* Some thickening times of 40 percent DE admixed with Class A cement are presented in Table 1, Part A. They vary from

1 hour 18 minutes at minimum water to 6 hours 36 minutes at maximum water when measured at 80° to 180° F. The thickening times at 80° to 140° F. vary from 1 hour 26 minutes to 12 hours 32 minutes for this density range.

A plot of these thickening time data, Figure 2, shows discontinuities between 210 and 220 percent water and 230 and 240 percent water for 140° F. and 180° F. thickening time, respectively. At both temperatures there is an abrupt increase in thickening time with water content. This can be explained by referring to the thickening time curves for 140° F. (Figure 3). For water concentrations less than 210 percent the thickening time curves are typical of those obtained for most cements. At greater water concentrations, the consistency initially increases in the normal manner. However, it breaks before reaching 100 poise and remains relatively constant for some time before increasing rather slowly to 100 poise, thus giving an increased thickening time. If a line connecting the breaks in the thickening time curves is extended it will pass just to the right of the 210 percent water curve at 100 poise. This suggests that if the consistency measurement were carried to some value higher than 100 poise, curves for the heavier slurries would also pass through an inflection. When the temperature is changed the slurry density, call it a critical density at which the maximum first appears, shifts in the direction opposite the temperature change. Thus at 180° F. the maximum does not appear at water contents less than 240 percent.

The reason for this inflection is not clearly understood; however, it seems to have no effect on the strength attained by the sample. This means then that the extended thickening time is a bonus providing the peak viscosity is not excessive.

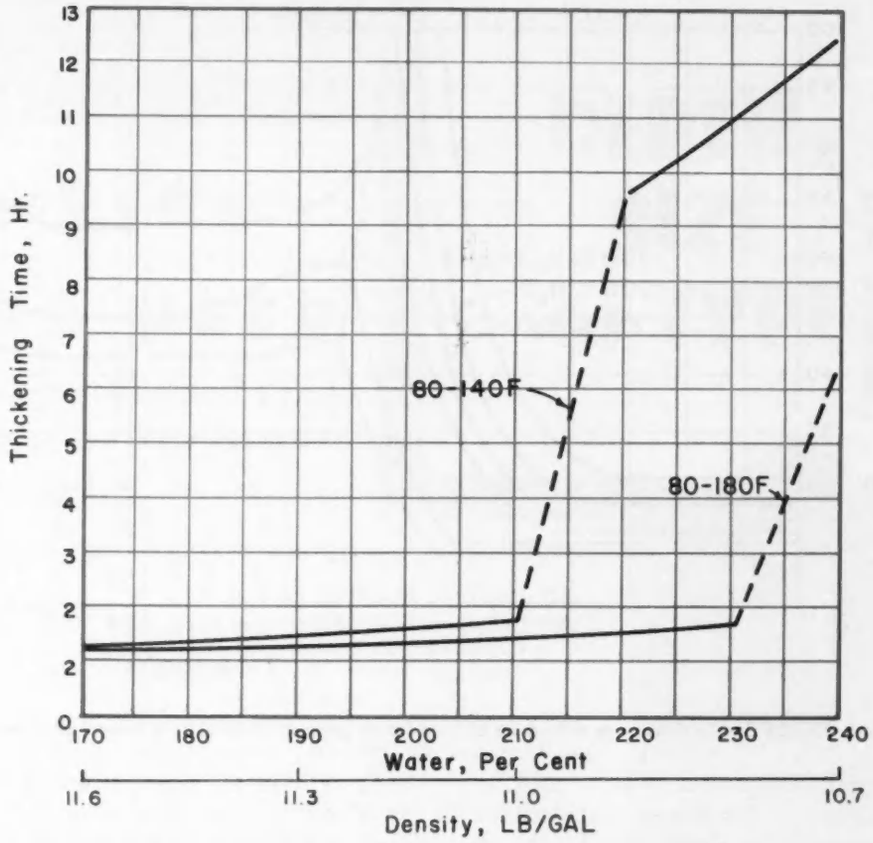


FIGURE 2—Thickening time as a function of the density or percentage water for slurries prepared with class A cement containing 40 percent DE.

3. *Well Simulation Thickening Times:* Thickening time data show that DE cement slurries are normal with regard to the effect of water and of temperature. Therefore, the super pressure thickening times were measured only to establish limiting conditions for placement depth of the slurries (Table 1).

A knowledge of a specific thickening time does not necessarily permit one to predict other thickening times with any accuracy. As for thickening times determined at atmospheric pressure the values obtained under simulated well conditions depend upon whether the curve has an inflection. Consistencies measured under pressure are less likely to pass through a maximum before thickening but tend to form plateaus when plotted against time.

4. *Compressive Strength:* Compressive strengths for DE cements cured at 140° and 160° F. are given in Table 2. Compressive strengths for these cements cured at temperatures less than 140° F. are given as entries for zero calcium chloride concentration in Tables 3 through 6.

Assume now, that 200 psi is ample compressive strength for most cementing operations even though the earlier discussion has indicated that strength requirements vary with the desired application. Class A cement containing 40 percent DE and 220 percent water has 24-hour compressive strengths of 110 and 500 psi when cured at 120° and 140° F., respectively. The temperature at which 200 psi is developed is approximately 130° F. This would indicate that this system is limited to use where temperatures are 130° F. or higher. However, if a long casing string is to be cemented from shoe to surface, a 40

TABLE 2
Compressive Strength of Specimens Containing Class A Cement, DE, and Varying Amounts of Water

	COMPRESSIVE STRENGTH, PSI					
	Cured at 140 F for:			Cured at 160 F for:		
Water, Percent	1 Day	3 Days	7 Days	1 Day	3 Days	7 Days
Part A: 40 Percent DE with Class A Cement:						
240	435	640	700	600	720	770
220	500	800	850	830	840	970
200	660	990	1080	1030	1100	1170
180	880	1280	1370	1360	1470	1560
Part B: 20 Percent DE with Class A Cement:						
140	810	1090	1150	1020	1140	1230
130	1030	1350	1440	1190	1310	1380
120	1300	1680	1800	1450	1610	1710
110	1540	2100	2200	1910	2050	2140

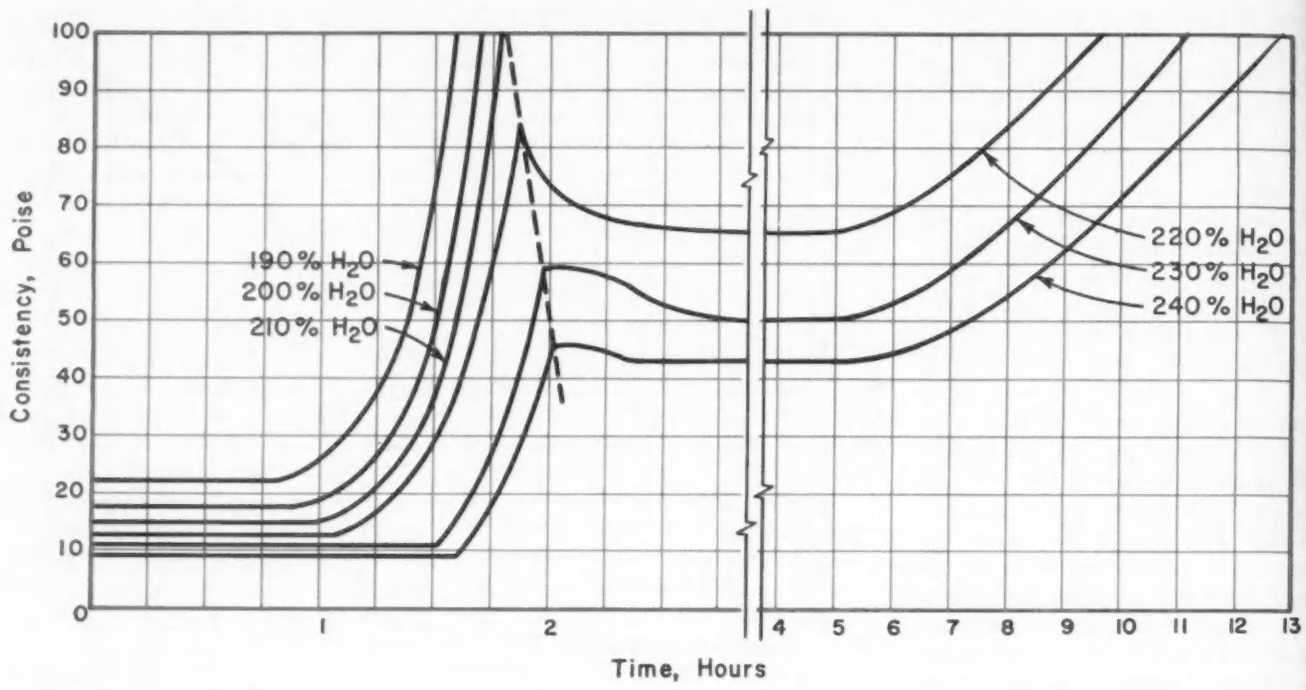


FIGURE 3—Consistency as a function of time for 40 percent DE in class A cement as determined in a consistometer at 80°—14° F.

percent DE cement might be used. In this case, if the bottom of the cement column is at about 130° F., the 40 percent DE cement could be followed with stronger cement, say 50 sacks of neat. This would provide high strength at the bottom while permitting use of inexpensive cement for fill-up.

Class A cements show losses in early strength when cured above a critical temperature. The strength retrogression becomes more pronounced with curing time for the first seven days. Recent work by the API Mid-Continent District Committee on Cementing Practices and Testing of Oil Well Cements[3] has shown that this critical temperature is shifted to a higher value by curing under pressure. Critical temperatures of 240° and 200° F. at one and three days curing, respectively, are typical for Class A cement cured at 2000 psi or higher. At atmospheric pressure the critical temperature is about 150° F.

This same sort of strength development was noted with the 20 percent DE system after three days curing, the critical temperature at atmospheric pressure being about 145° F.

TABLE 3

Compressive Strength of Class A Cement Containing DE and Calcium Chloride Cured at 120° F.

$CaCl_2$, Percent	Water, Percent	COMPRESSIVE STRENGTH, PSI CURED FOR: 1 Day	2 Days	3 Days
Part A: Class A Cement containing 40 percent DE:				
0	220	110	400	610
2	220	240	....	800
4	220	300	500	870
6	220	330	520	1000
10	220	340	....	1110
0	200	130	590	750
4	200	520	....	1220
6	200	540	620	1230
0	180	260	....	1120
4	180	530	760	1530
6	180	580	1300	1490
Part B: Class A Cement containing 20 percent DE:				
0	140	180	700	930
2	140	450	830	1080
4	140	450	840	1040
0	130	250	610	950
2	130	520	850	1120
4	130	540	900	1180
0	120	510	850	1220
2	120	660	1110	1410
4	120	680	1140	1470
0	110	720	1020	1420
2	110	830	1340	1790
4	110	840	1480	1980

TABLE 4

Compressive Strength of Class A Cement Containing DE and Calcium Chloride Cured at 100° F.

$CaCl_2$, Percent	Water, Percent	COMPRESSIVE STRENGTH, PSI CURED FOR 1 Day	2 Days	3 Days
Part A: Class A Cement containing 40 percent DE:				
0	220	60	110	210
4	220	130	230	430
6	220	120	260	400
0	200	85	150	300
4	200	190	440	660
6	200	200	420	630
0	180	140	....	520
4	180	260	....	920
6	180	290	....	890
Part B: Class A Cement containing 20 percent DE:				
0	140	160	280	420
2	140	260	460	690
4	140	240	480	660
0	130	140	280	390
2	130	300	480	640
4	130	300	500	700
0	120	290	360	540
2	120	380	590	830
4	120	380	620	880
0	110	410	530	750
2	110	510	850	1160
4	110	520	870	1220

TABLE 5

Compressive Strength of Class A Cement Containing DE and Calcium Chloride Cured at 80° F.

$CaCl_2$, Percent	Water, Percent	COMPRESSIVE STRENGTH, PSI CURED FOR 1 Day	2 Days	3 Days
Part A: Class A Cement containing 40 percent DE:				
0	220	25	55	70
4	220	45	100	150
6	220	55	100	140
0	200	30	60	80
4	200	70	140	200
6	200	60	110	160
0	180	50	100	140
4	180	95	160	170
6	180	100	160	240
Part B: Class B Cement containing 40 percent DE:				
0	140	55	160	230
2	140	150	300	390
4	140	150	290	390
0	130	70	170	240
2	130	170	300	400
4	130	170	300	420
0	120	93	220	310
2	120	200	380	530
4	120	210	410	530
0	110	120	300	440
2	110	300	530	720
4	110	300	580	640

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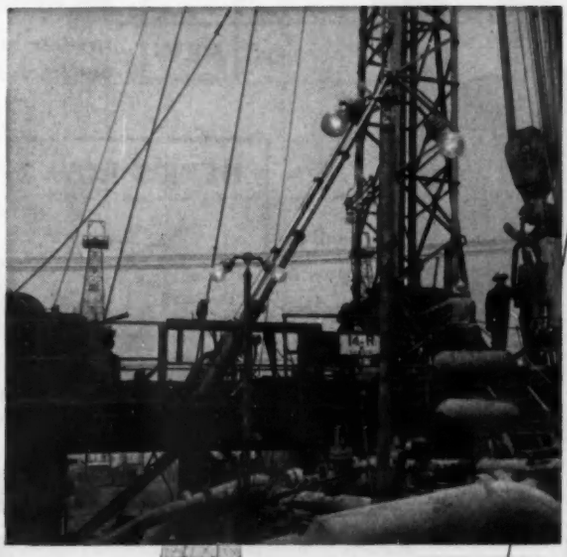

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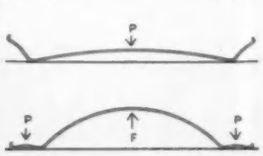

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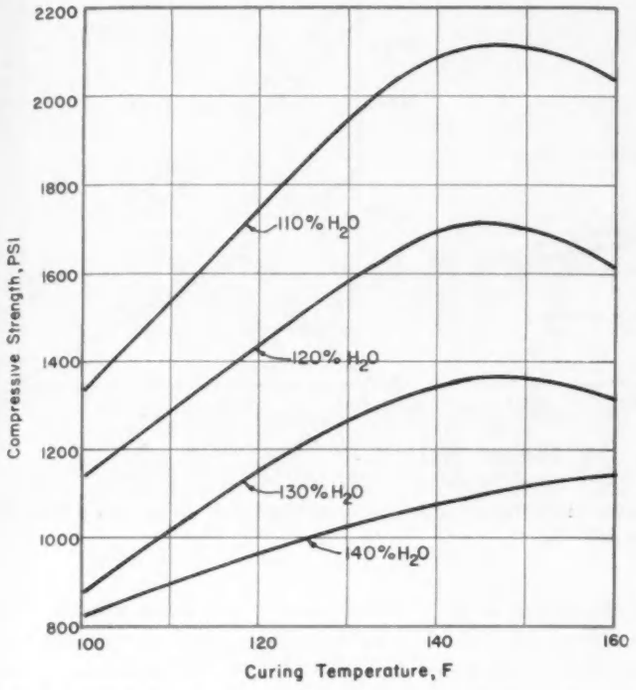

FIGURE 4—Effect of curing temperature on 3-day compressive strength of specimens containing 20 percent DE and class A cement.

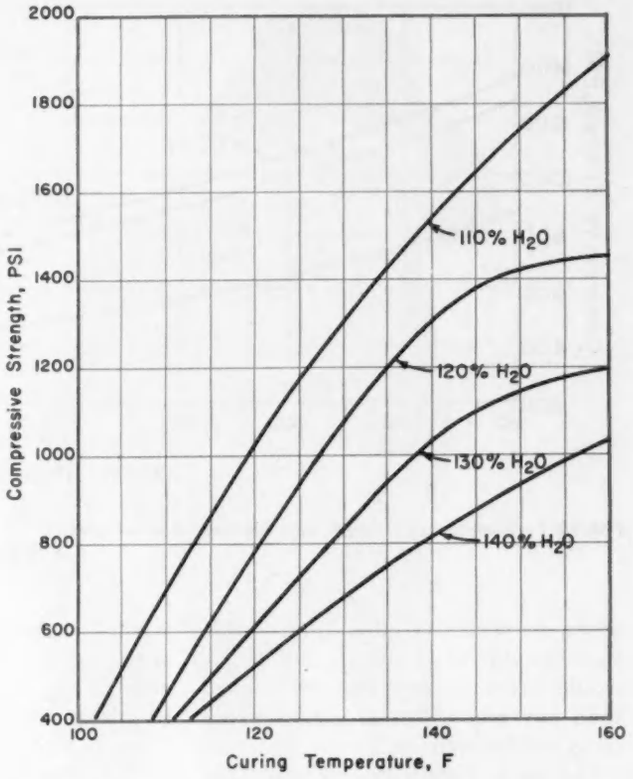

FIGURE 5—Effect of curing temperature on 24-hour compressive strength of specimens containing 20 percent DE and class A cement.

(Figure 4). The addition of DE however, seems to have shifted the critical temperature at 24-hour curing to a value above 160° F. (Figure 5). With the addition of more DE (40 percent) the critical tempearture does not appear below 160° F. even after three days (Figure 6). These facts are consistent with observations on the pozzolanic action of diatomaceous earth. It has been stated that the cementitious quality of diatomite as a pozzolan increased with time and temperature.[10] Any retrogression experienced

TABLE 6
Compressive Strength of Class A Cement Containing DE and Calcium Chloride and Cured at 2,000 Feet API Simulated Depth

Density, Lb./Gal.	$CaCl_2$, Percent	Water, Percent	COMPRESSIVE STRENGTH PSI CURED FOR: 1 Day	2 Days	3 Days
Part A: Class A Cement containing 40 percent DE:					
11.1	0	220	110	370	520
11.1	4	220	210	510	580
11.1	6	220	230	510	590
11.3	0	200	150	520	720
11.3	4	200	300	660	800
11.3	6	200	240	690	780
11.5	0	180	220	610	820
11.5	4	180	420	780	1170
11.5	6	180	420	860	1170
Part B: Class A Cement containing 20 percent DE:					
12.15	0	130	350	780	1090
12.15	2	130	520	770	1130
12.15	4	130	500	710	1190
12.15	6	130	500	740	.....
12.15	8	130	470	660	.....
12.4	0	120	500	790	1280
12.4	2	120	670	950	1450
12.4	4	120	630	950	1440
12.6	0	110	660	1040	1580
12.6	2	110	760	1240	1790
12.6	4	110	790	1220	1800

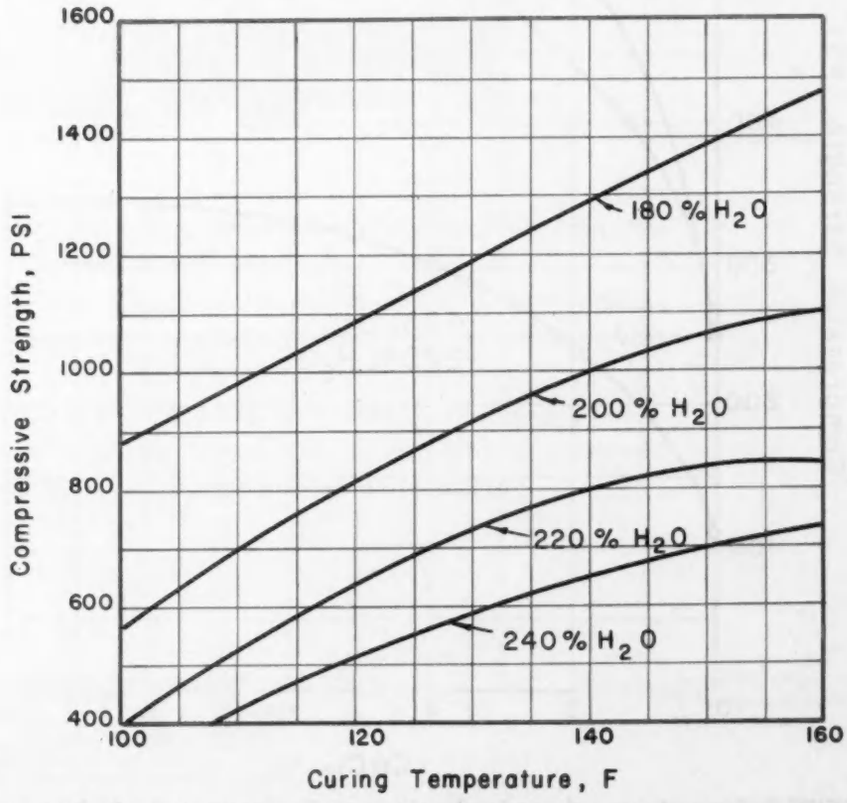

FIGURE 6—Effect of curing temperature on 3-day compressive strength of specimens containing 40 percent DE and class A cement.

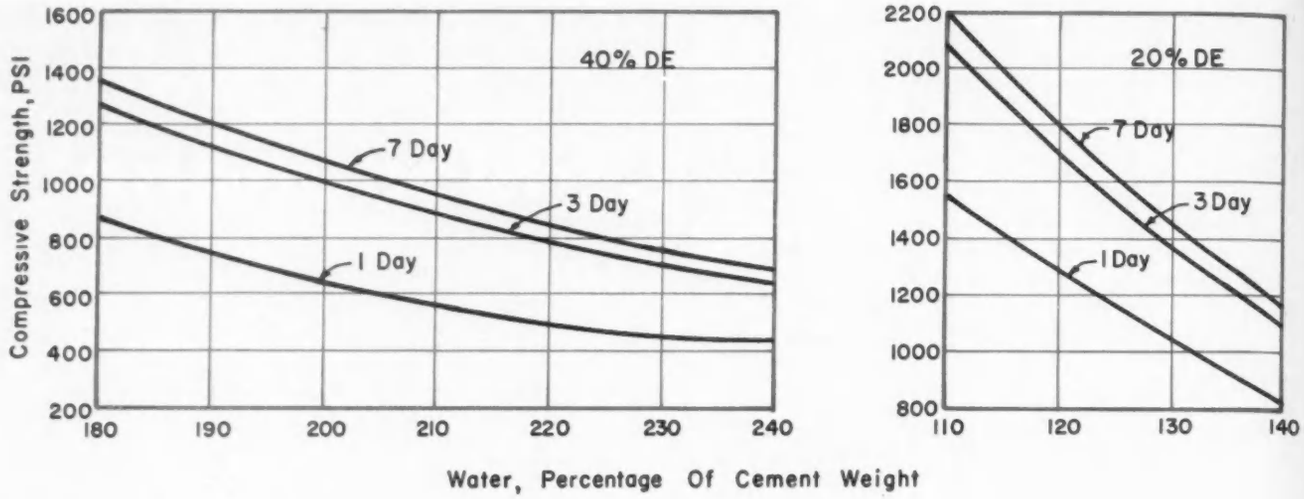

FIGURE 7—Compressive strength as a function of water content for specimens containing class A cement admixed with 20 and 40 percent DE and cured at 140° F.

when the cement is cured under pressure would be unimportant as it would occur at temperatures higher than any where this type of DE cement will be used.

Compare Figure 2 (the effect of water content on the thickening time) with Figure 7 (the effect of water content on the compressive strength of DE cement). Even though discontinuities exist in the thickening time curves, the curves of strength versus water content are quite smooth. This would indicate that the presence of the inflection in the thickening time curve has no effect upon the ultimate strength of the cement.

5. *Density Measurements:* The measured slurry densities agree within 0.2 pound per gallon with the densities as computed from the absolute densities of cement, DE, and water. Therefore, a significant increase in the density of the slurry with pressure, such as that experienced with expanded perlite is not encountered. Density measurements on the top and bottom halves of cured specimens show no settling of the solids in the slurry.

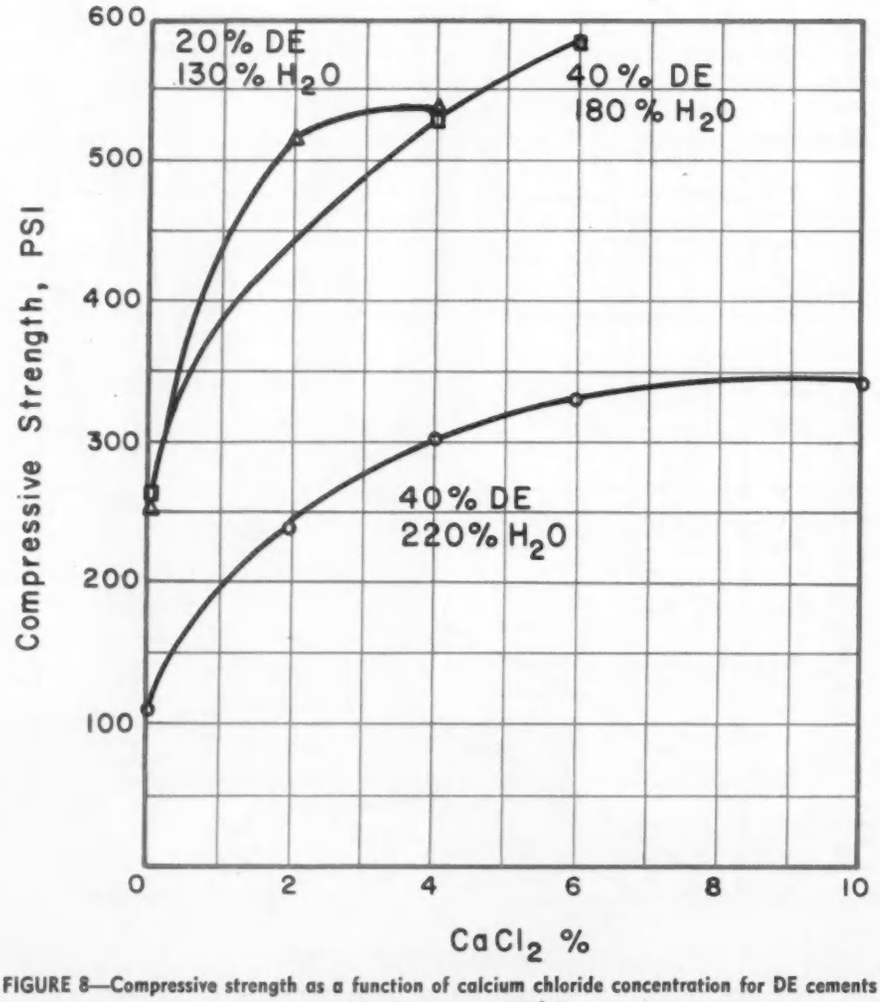

FIGURE 8—Compressive strength as a function of calcium chloride concentration for DE cements cured for 24 hours at 120° F.

C. Accelerated DE Cement

1. *Compressive Strength:* Several materials known to accelerate the early strength of portland cement were tested for effectiveness in 40 percent DE cement. Sodium and calcium chloride were the best accelerators. Because of its wide usage as a cement accelerator, calcium chloride was chosen for further investigation.

Small amounts of calcium chloride cause a rapid increase in the early strength of DE cement. However, this benefit becomes progressively smaller with increased calcium chloride concentration (Figure 8). Thus, the most economical concentration is one giving somewhat less than maximum benefit. With 40 percent DE, this concentration has been chosen as 4 percent. With the 20 percent DE cement system, 2 percent calcium chloride is preferred. The more detailed tests with calcium chloride as

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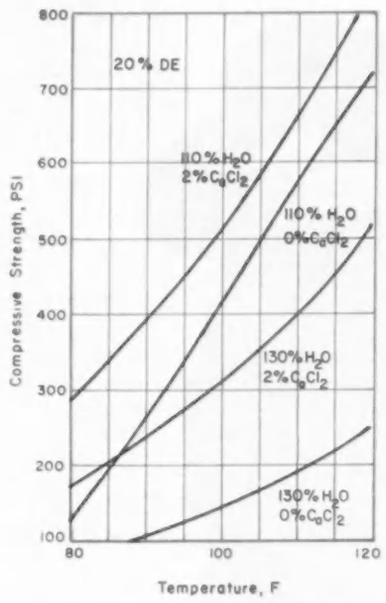


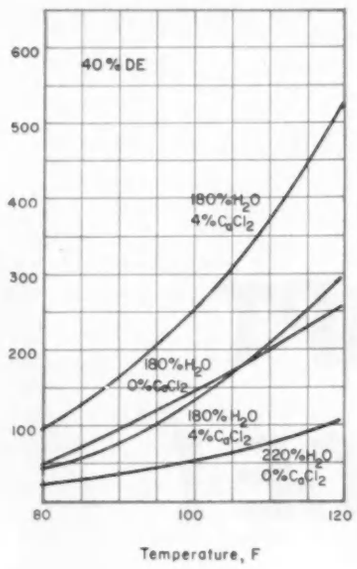
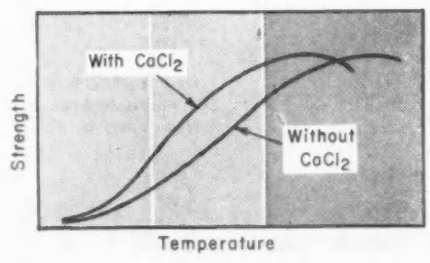


FIGURE 9—24-hour compressive strength of 20 and 40 per cent DE cement systems over the temperature range from 80 to 120° F.

an accelerator in DE cements are listed in Tables 3 through 6.

The 24-hour compressive strength at 80° F. is at least doubled by the addition of the recommended amount of calcium chloride to DE cement. In most cases, a plot of compressive strength as a function of temperature for 80° to 120 F. shows that strengths of DE cements become more temperature dependent with the addition of calcium chloride (Figure 9). This is true only over the temperature range studied. In general, the curve of strength as a function of temperature for any cement will increase with temperature, has an inflection, and then a maximum as noted on the accompanying sketch. Calcium chloride or any other accelerator shifts the strength curve lower on the temperature scale. Since this study has been in the part of the temperature range included in the dotted lines it would appear that DE cement accelerated with calcium chloride is more temperature sensitive than unaccelerated DE cement, but this is true only for a limited temperature range.



When DE cements were cured at an API simulated depth of 2000 feet (110° F. and 1600 psi) the compressive strengths were from 10 to 30 percent greater than those of DE cements cured at the same temperature and atmospheric pressure (Table 6).

2. *Thickening Time:* Section B, on DE cements, discusses an inflection which occurs in the consistency versus time curve of DE cement slurries.

TABLE 7

Stanolind Thickening Times of Slurries Containing Class A Cement, DE and Calcium Chloride

$CaCl_2$, Percent	Water, Percent	SUPER-PRESSURE THICKENING TIME, HR:MIN. AT A SIMULATED DEPTH OF: 6,000 Ft.	8,000 Ft.	10,000 Ft.	12,000 Ft.
Part A: Class A Cement containing 40 percent DE:					
0	220	.....	.....	7:00	2:18
4	220	.....	.....	7:13	1:40
6	220	.....	.....	3:13	1:24
0	200	.....	.....	3:22	.....
4	200	.....	.....	2:02	.....
6	200	.....	.....	1:13	.....
0	180	.....	1:44	1:12	.....
4	180	.....	1:40	1:10	.....
6	180	2:31	1:48	1:26	.....
Part B: Class A Cement containing 20 percent DE:					
0	140	2:16	2:00	.....	.....
2	140	2:13	1:58	.....	.....
4	140	.....	2:27	.....	.....
0	130	2:08	2:00	.....	.....
2	130	2:26	1:46	.....	.....
4	130	2:12	1:50	.....	.....
0	120	2:22	1:39	.....	.....
2	120	1:54	1:34	.....	.....
4	120	1:52	1:32	.....	.....
0	110	2:15	1:35	.....	.....
2	110	1:47	1:31	.....	.....
4	110	2:12	.....	.....	.....

This inflection appears in the curves obtained from slurries of 40 percent DE cement having densities less than 12.35 pounds per gallon (200 percent water). It was again noted in this study. The addition of calcium chloride tends to reduce or eliminate abnormally long thickening times of slurries which give inflections, thus accounting for rather large reductions in the thickening times of slurries containing 40 percent DE and 200 or greater percent water. Since these thickening times were abnormally long before the addition of calcium chloride, such additions do not materially reduce the maximum depth to which DE cements can be used. Calcium chloride has little effect on the thickening time of slurries which do not yield consistency curves with inflections (Table 7).

CONCLUSIONS

- Cements having slurry densities ranging from 10.5 pounds per gallon to that of neat cement are possible with the proper adjustment of DE concentration.
- Slurry densities of DE cements are not significantly altered by pressure.
- The slurry density reductions are attainable only at some sacrifice in strength. For most cementing operations this is not seirous if care is taken in the proper selection of the cement.
- Calcium chloride can be used to accelerate the early strength of DE cements.

ACKNOWLEDGMENT

The use of diatomaceous earth of a suitable type for control of the slurry density of oil well cements was suggested by Roy Bobo of Phillips Petroleum Company's Production department. The Johns-Manville Corporation was helpful with material and technical assistance throughout this study. The application of this system to oil well cementing operations is being handled by the Drilling Specialties Company of Bartlesville, Okla.

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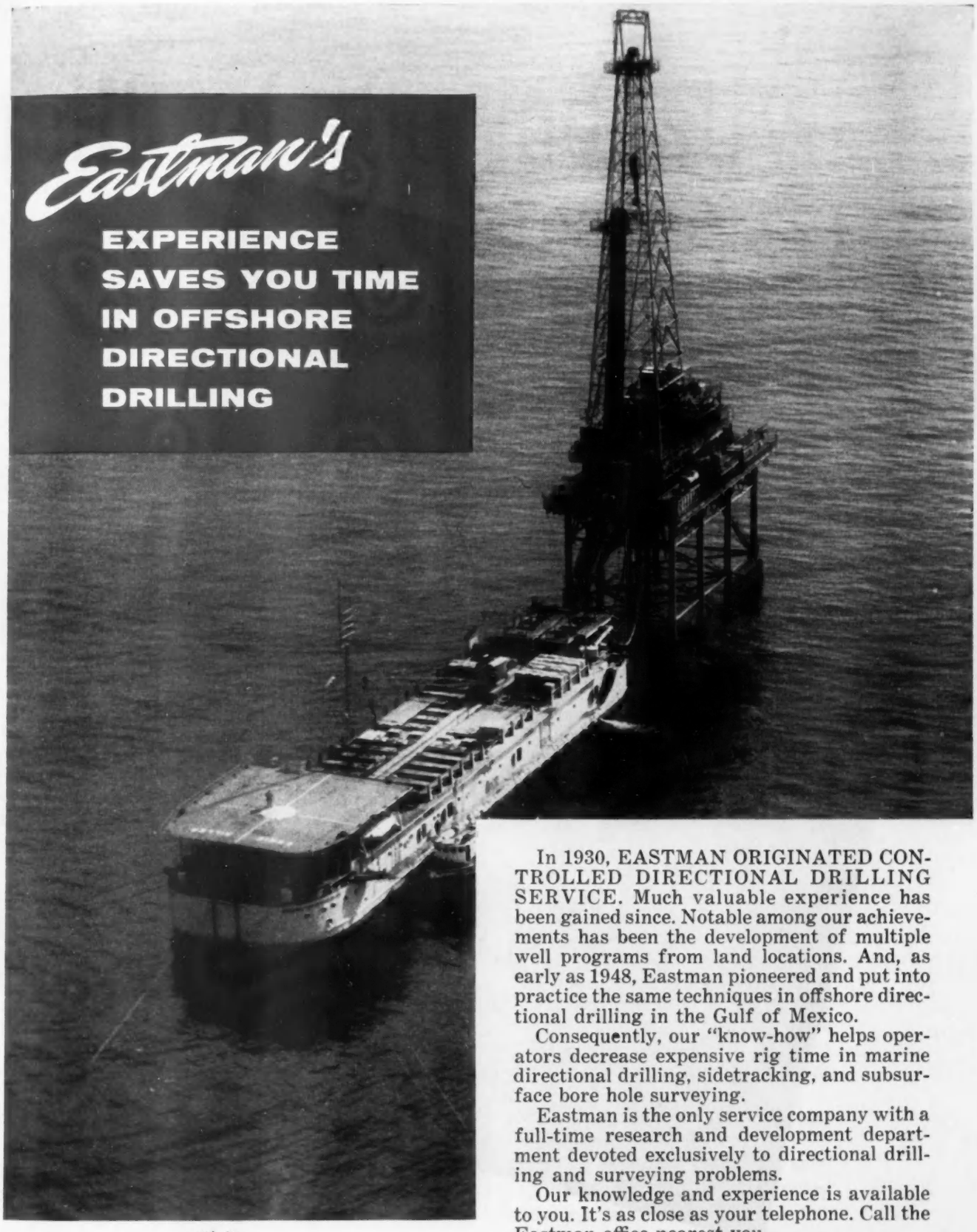
[10] Comments by D. R. MacPherson, Johns-Manville Corporation.



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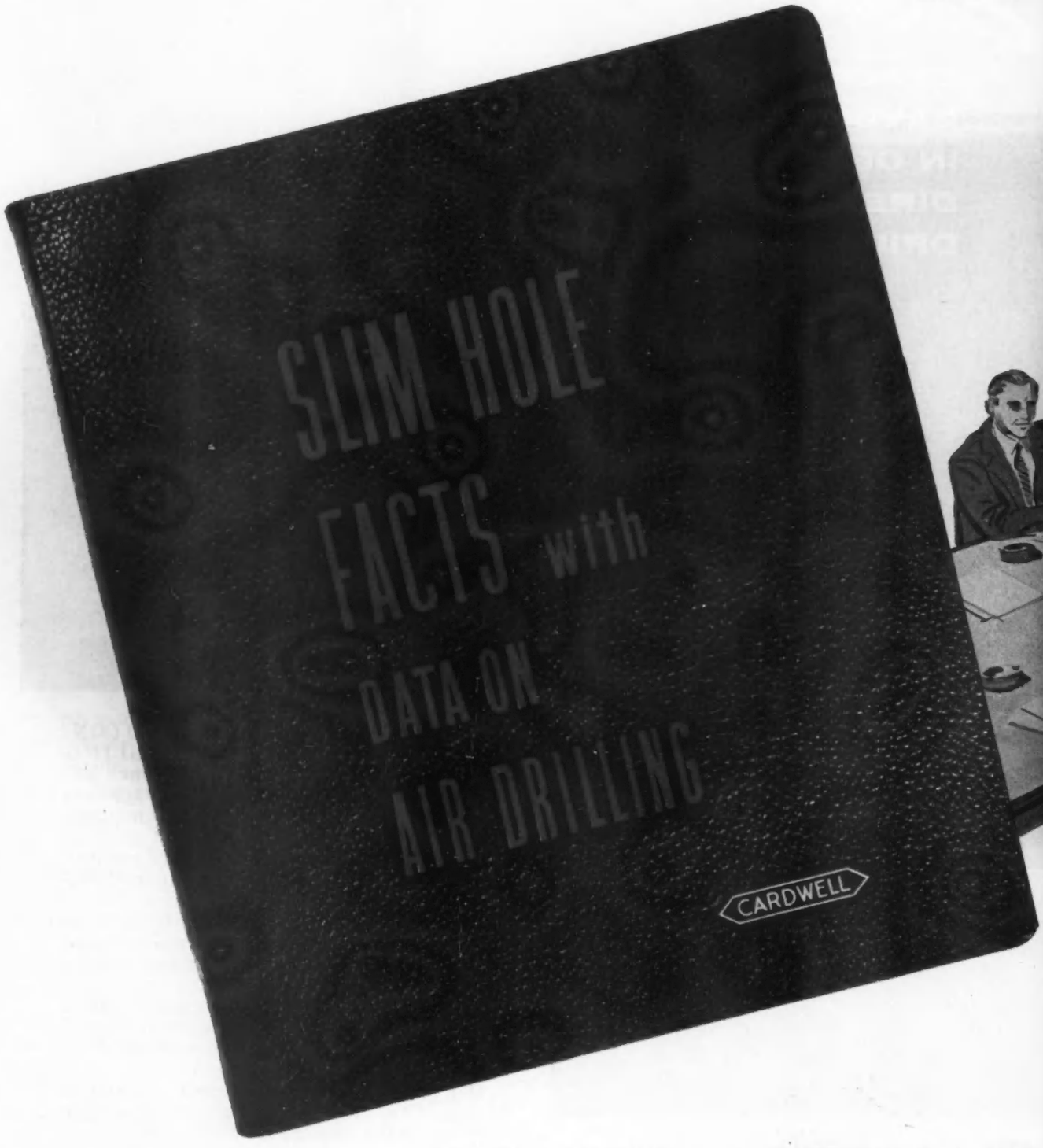

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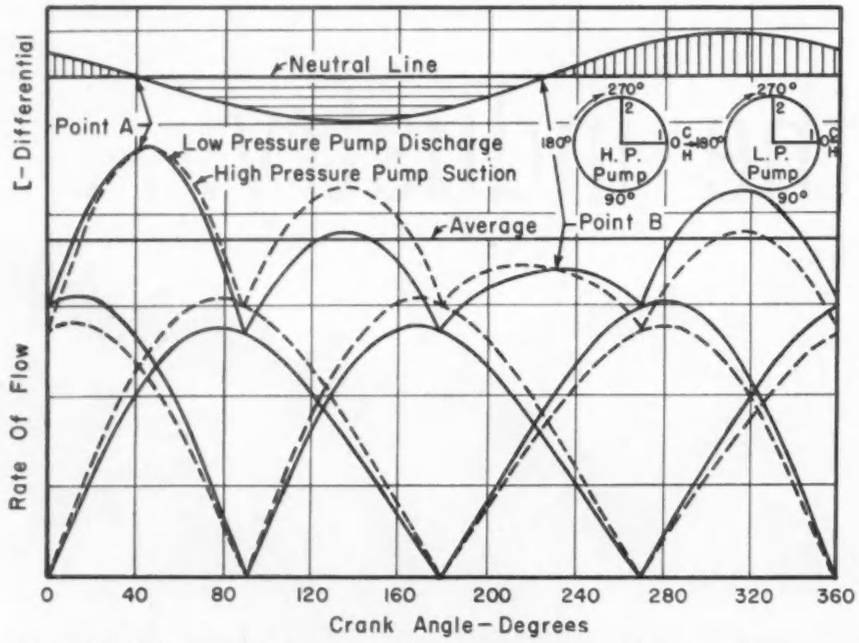

FIGURE 12—This illustrates the problems involved in series operation. Note that the low pressure discharge and the high pressure suction curves are not identically shaped. This will create a deficiency or excess of fluid between the two pumps.

Trends Toward Large Rigs And Fluid-Driven Pumps

What operating characteristics make the torque converter preferable to the hydraulic coupling?

By H. L. WILLKE
The National Supply Company
Toledo, Ohio

A DISCUSSION of modern pumps and their use would not be complete without a word on compounding. The use of jet bits for all areas is rapidly becoming accepted. In a large number of cases rigs are too short of horsepower and pump capacity, so the operator is left with the problem of how to supplement his rig with this extra capacity. In some cases this can be answered by repowering the rig and adding larger pumps. In other cases this is being accomplished by adding a separately driven pump of sufficient size and with sufficient horsepower. As either of these methods is an economical burden the operator is occasionally forced to a compound operation.

Parallel compounding has gained wide acceptance and is quite easy to accomplish. In some cases, in order to reduce the over-all pressure variation, pumps have been mechanically tied together in a certain phase relationship which tends to eliminate instantaneous overloads on the power end.

PART 2

In other cases adequate air chambers have overcome any serious result from this tendency to overload. Precharged air chambers are available today that will fulfill this purpose. The only limitation to this type operation is that in some cases the fluid pistons need to be reduced below a practical size. For this condition compound operation must be conducted with the pumps in series.

Figure 12 illustrates the problem involved in series operation. Because the low pressure pump discharge and the high pressure pump suction are not identically shaped curves for any position of the crankshafts there will always be either a deficiency of fluid or an excess amount of fluid between the two pumps. The period of insufficient fluid is indicated by the horizontally shaded area at the top of Figure 12, while the period of excess amount of fluid is shown by the vertical shading. These areas are greatly affected by the phase relationship of the pump and take on many shapes and sizes as the phase relationship shifts. The problem in series operation is to eliminate these differences in discharge and suction characteristics.

Attempts have been made to accomplish series operation through hydraulic drives. This can be done successfully at slow speeds, but at high speeds the inertias in the system become so great that the required result cannot be obtained. There will be instances where one of the pumps is carrying all of the load and consequently a 100 percent overload. The only successful method of compounding in series that is known is to use air chambers, preferably precharged chambers, of sufficient size to absorb all of the excess fluid with only a small pressure variation and to supply those periods of insufficient amounts of fluid. This is being accomplished today by using at least two of the larger precharged air chambers.

Fluid Drives. The first fluid drives were applied to drilling rigs in the late 1930's. These were both hydraulic couplings and torque converters. Hydraulic couplings were available in wide horsepower ranges while converters were limited in capacity and could only be used on smaller rigs. At the outset converters were plagued with mechanical difficulties and as a

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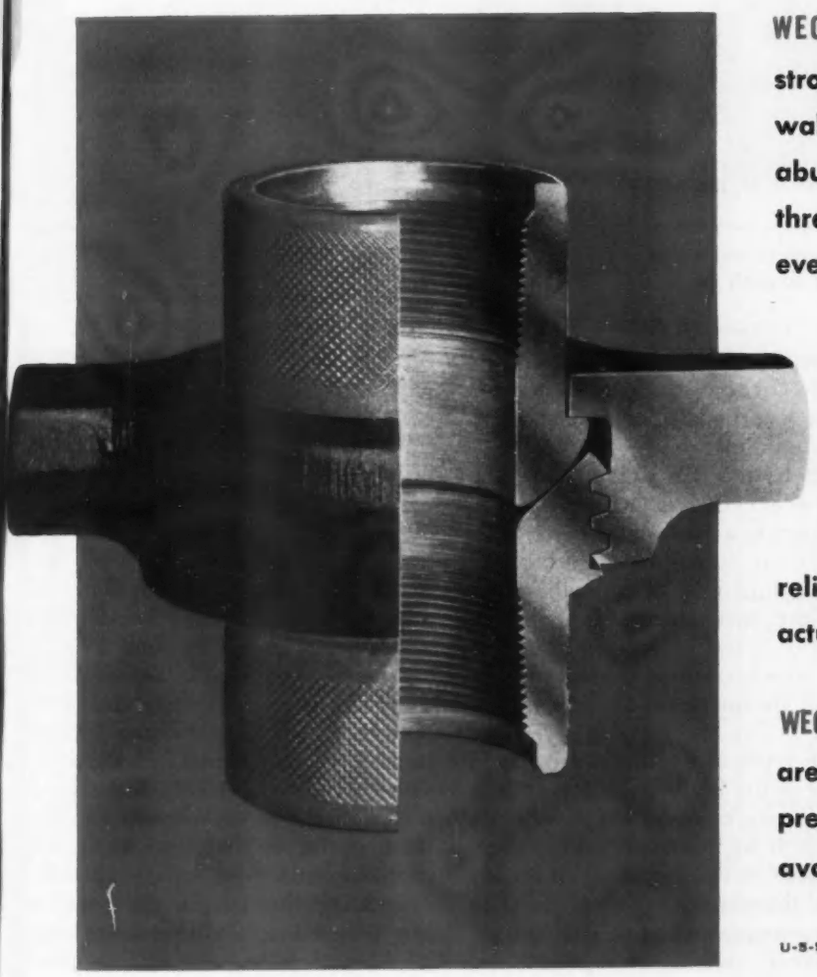

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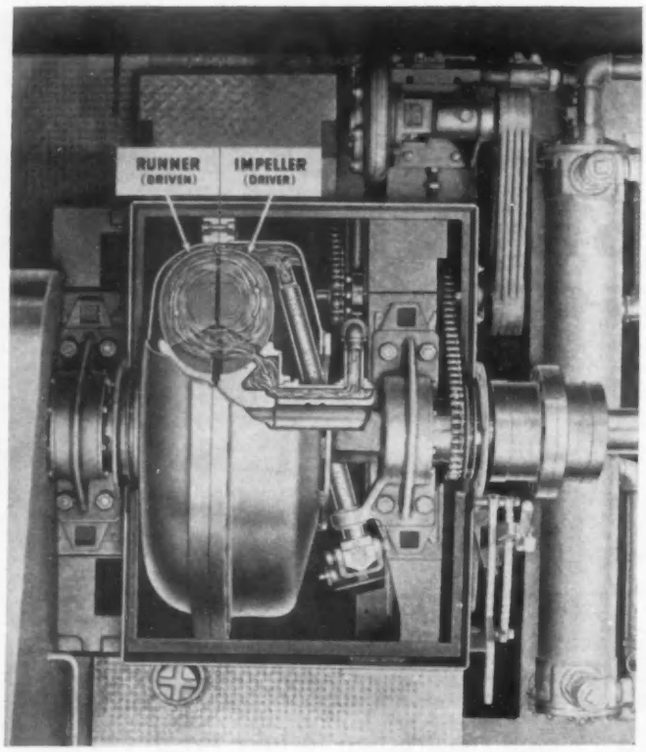


FIGURE 13—Cutaway of a typical hydraulic coupling (above) shows partial filling of the fluid circuit under regulated control of the sliding scoop.

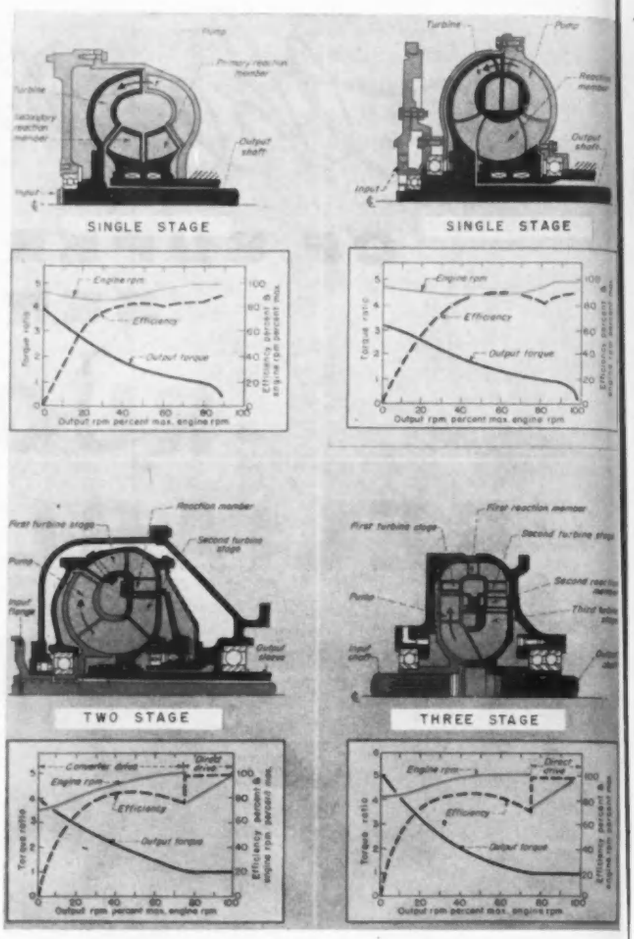


FIGURE 14—At right are 1-, 2-, and 3-stage converters currently in use, plus their operating characteristics.

result hydraulic couplings began to predominate.

During World War II torque converters were redesigned for greater durability, but the horsepower ranges were only slightly increased.

The characteristics of the converter were well adapted to the hoisting function of a rig. Within a few years after the war they were accepted as the standard drive for all small rigs, and have held this position ever since. Hydraulic couplings, developed for capacities up to 700 hp, as against 300 hp for torque converters, were still in favor on large rigs.

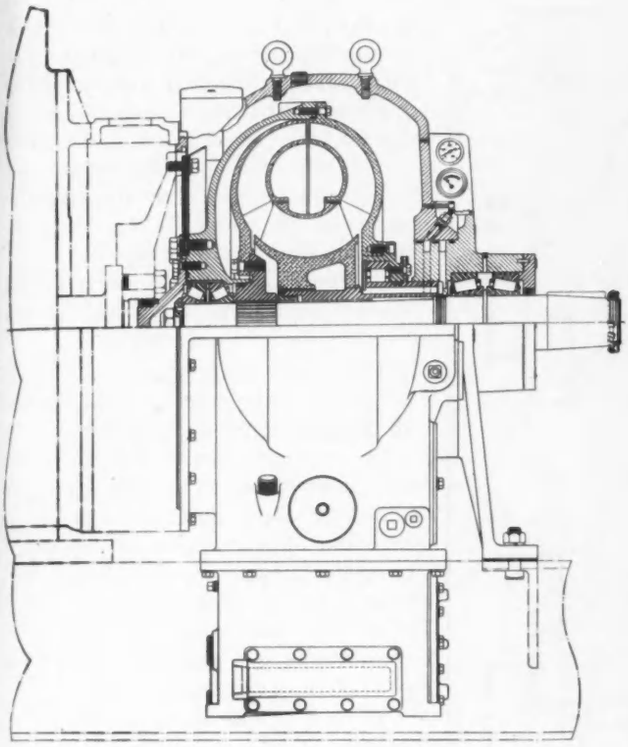
Hydraulic couplings and torque converters have many common characteristics which are of great benefit to a rig drive. They each divide the mass system of the engine from the mass systems of the driven machinery and, thus, it becomes a simple matter to match the masses of the input side of the hydraulic drive to the engine masses and prevent serious torsionals from existing in the operating speed of the engine. On a mechanical rig this is an extremely complex problem because all of the shafts in a compound will differ in arrangement and they would all have to be treated differently. In some cases, the elimination of a torsional vibration becomes almost an impossibility.

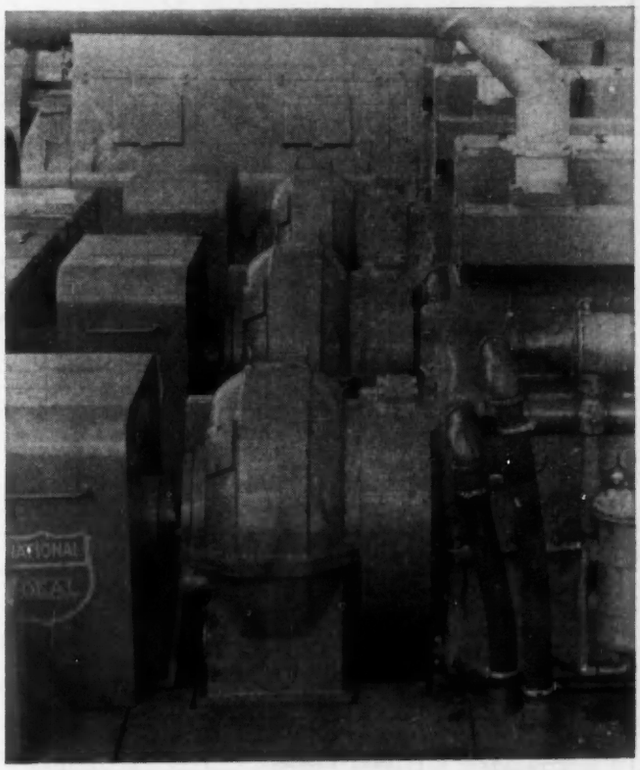
Both hydraulic drives have the ability of greatly reducing shock when compared to a mechanical drive. This is of great importance during the hoisting functions of a drilling rig. Even the engagement of a friction clutch on a mechanical rig can be a severe shock causing extreme instantaneous overloads on all driving elements.

Both types of hydraulic drives add greatly to the flexibility of a rig. On a mechanical rig operating speeds are limited to approximately 40 percent of throttle to full engine speed on any of the drawworks ratios. Reductions in these speeds will cause engine stalling. Where inching of a load is required, it can only be accomplished by slipping the clutch. This causes severe heating. With either type hydraulic drive speeds can be reduced to zero without causing unfavorable loads on the engines. In the case of the hydraulic coupling this can be accomplished by engine throttle and partial filling. In the case of the torque converter only throttle manipulation is required.

A typical hydraulic coupling, illustrated in Figure 13, consists of two principle elements. The impeller which absorbs the horsepower from the engine and the runner which transmits the power hydraulically into the driven elements. In this hydraulic coupling a scoop has been added which serves two functions. First, it constantly scoops a quantity of oil from the operating circuit and circulates it through a heat exchanger and back into the coupling. Second, by varying the depth at which the scoop is extended it serves to control partial filling of the coupling, and, as a result, partial speeds. Also by completely evacuating the circuit the coupling can be used as a disconnect clutch. The coupling is basically a 1-to-1 torque ratio drive. The output torque is always equal to the input torque.

Figure 14 illustrates several types of converters currently in use. The three stage converter was first introduced into the oil fields and is one of the better known types. In addition to the pump which adsorbs the engine's power, the three stage converter has





FIGURES 15 and 16—The diagram and photo are of a large single-stage converter which has been developed for use on large drilling rigs.

three turbine elements interposed by two stator elements. The two stage converter has one less turbine and one less stator while the single stage has only one of each of the basic elements. The basic differences in these converters is that the higher number of stages allow for higher torque multiplications while the lower number of stages have better efficiencies. Since most drawworks have a sufficient number of speeds, the higher torque multiplications of the multi-stage converters are not necessary. As a result, single-stage converters are gaining favor.

One other significant difference in these types of converters is that in the single-stage converter, the stator is adjacent the inlet side of the pump. This gives this type converter a flat power absorption characteristic which will be discussed later.

A direct comparison of torque converters and hydraulic couplings is given on Figure 17. The shape of the torque absorption curves is identical except in magnitude. This can be seen in comparing the curve labeled 29.5-inch converter (input torque), which is for a converter, as against the curve labeled 27-inch hydraulic coupling. The curves labeled 27-inch dual hydraulic coupling and 31.5-inch hydraulic coupling are similar. They have not been extended throughout the speed range because of lack of space. However, they would also have this same general characteristic. It is

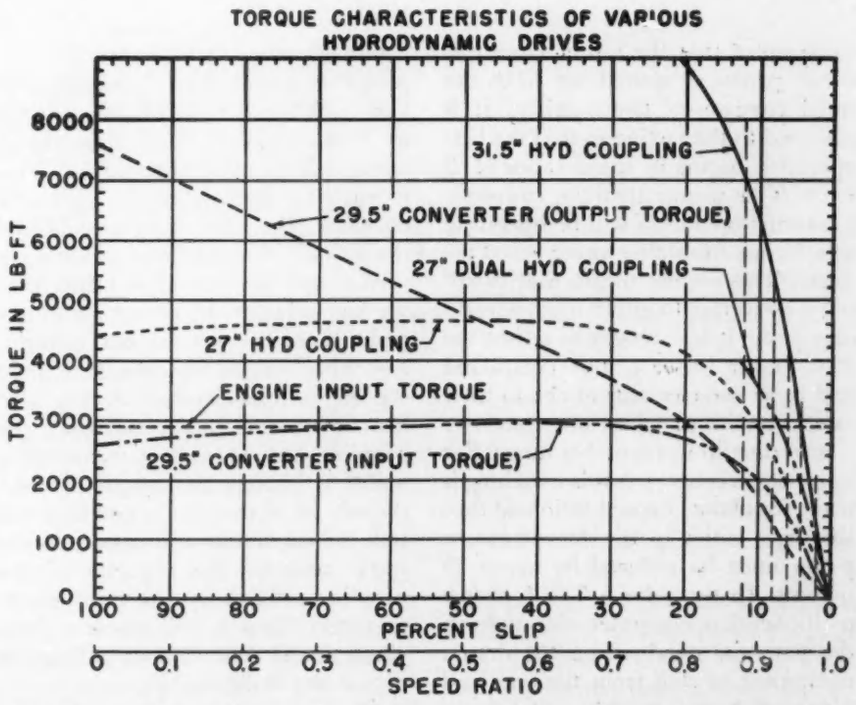
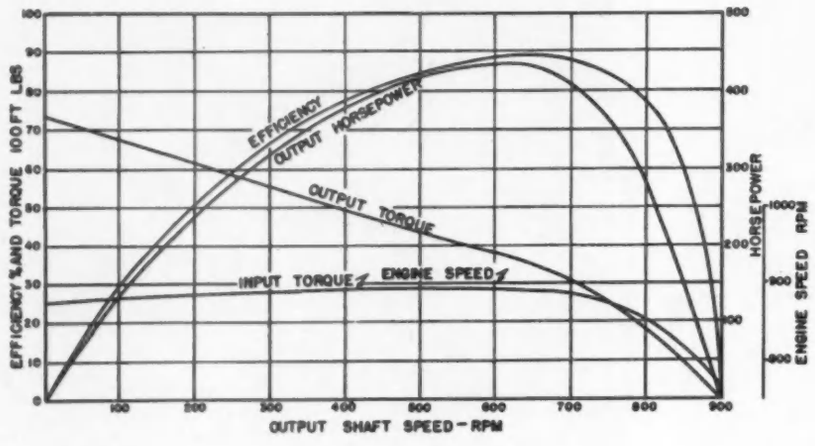
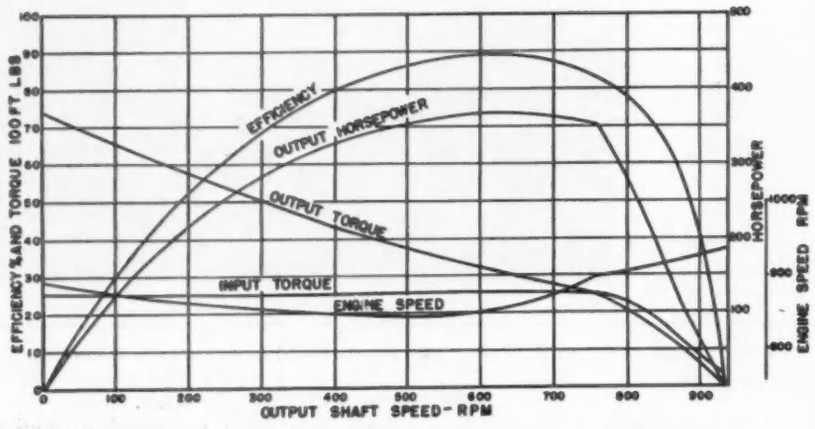


FIGURE 17—In this comparison of torque characteristics of converters and couplings, note that the shape of the torque absorption curves are identical except in magnitude.





FIGURES 18 and 19—Typical converter applications. In Figure 18 (top) the converter is small and the engine operates at full governed speed. In Figure 19 the converter is too large and the engine speed is pulled down slightly.

to be noted that the torque converter curve peaks at something near the rated torque of the engine. It is matched to the engine so that the best operation occurs in speed ratios of .3 to .7. This means that the converter in normal operation will be operating as a torque multiplier and a speed reducer. This further means that to apply a converter to either a drawworks or a pump it is necessary to adjust the drive ratio between the compound and these two elements to obtain their rated conditions when the converter is operating in its favorable range. For single-stage converters this matching is made for about .7 speed ratio and thus the drive ratios to the drawworks or pump must be reduced by about 35 percent. In turn, for a 3-to-1 torque multiplication converter this reduces the potential overload on the driven equipment at stall from the accepted figure of 3 to something slightly in excess of 2 to 1.

On the other hand, hydraulic couplings are matched to the engine at a very high speed ratio ranging from 3 to 7 percent and depending upon certain desired characteristics. This means that potentially the hydraulic coupling is a much larger hydraulic device than the converter as they are used on specific engines, but since they are basically one to one torque mutliplying devices they do not transmit any more torque into the load than the engine can develop. As the load demands more torque, and since the coupling has this torque transmitting ability it imposes this torque demand directly on to the engine and thus will pull the engine down in speed. As the speed reduces, the capacity of the coupling reduces by the third power of speed. Thus it will reach a point where it will stall without pulling the engine to a stalled condition.

There is a point of interest in comparing these characteristics. For a sudden shock in the drive mechanism the coupling can transmit, in addition to engine rated torque, any amount of torque that the engine can deliver due to its inertia. Whereas, the converter is already absorbing power to the maximum of its ability and therefore cannot affect the engine speed nor can it affect shock load in the drive by the inertia of the engine. It can only support the shock by reducing its output shaft speed in order to increase its torque multiplication. Thus it will effectively dampen the shock.

This figure illustrates that a converter has to be carefully matched to an engine. This explains why each converter manufacturer has so many sizes from which to choose. The coupling doesn't require this accurate matching. For example, an engine of twice the horsepower could be applied to a given coupling by simply doubling the application slip. The only compromise is a change in efficiency equivalent to the change in slip.

Typical converter applications to engines are shown in Figures 18 and 19. In the one case, the converter is slightly small and as a result, the engine operates at full governed speed over the entire range of converter output shaft speeds. In the other case, the converter is slightly large and during a portion of the converter speed ratios the engine speed is pulled down slightly. Thus, care must be taken in matching converters to engines.

In comparing couplings and converters, too often a direct comparison is made between the efficiencies. This is unfair to the converter. In addition to the desirable characteristics of hydraulic drives previously discussed, the converter has the ability to automatically shift the speed ratios to best adapt the engine horsepower to the load. While the converters rated efficiency values are lower than that of other types of drives it utilizes the capacity of the engine much more effectively and thus accomplishes more work even though it is less efficient. It also keeps the engine running under favorable conditions and in some cases, the fuel consumed isn't in inverse proportion to the mechanical efficiencies of the drive.

For a drive to be completely successful on a drilling rig, it must perform three types of function:

1. Operate under hoisting conditions. For this the converter is out-

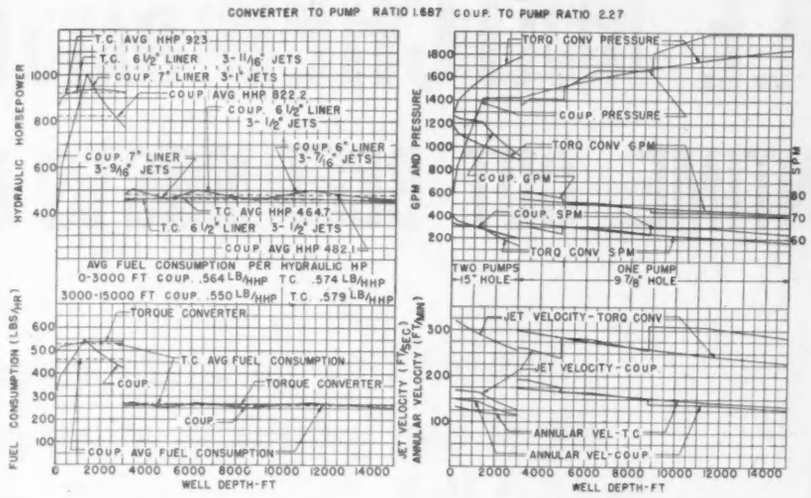


FIGURE 20—Shown is a comparison of a 31.5-inch coupling and a torque converter with a 700-hp pump and an engine rated at 622 hp. Two pumps were used in the surface hole.

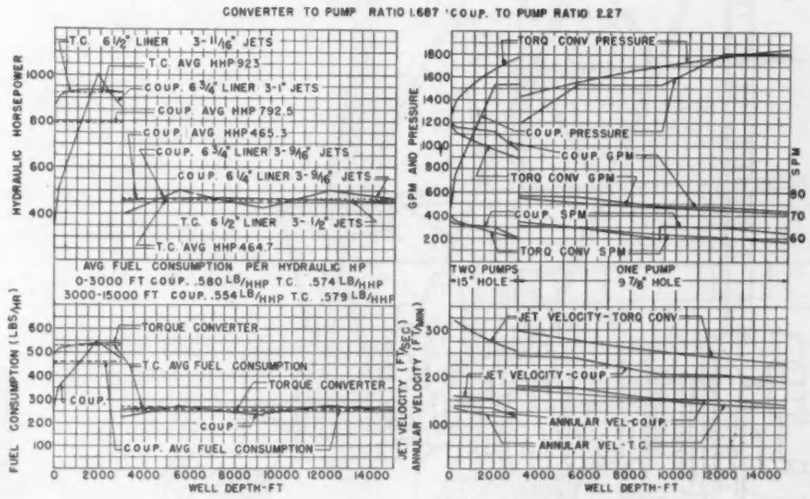


FIGURE 21—The same engine, pump and hole conditions were used on this example as in Figure 20. The only difference is that only two liner sizes were used.

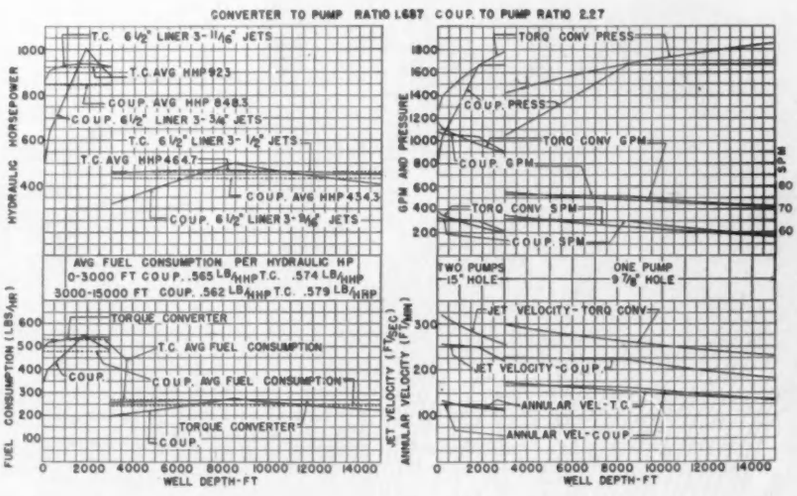


FIGURE 22—Here only one liner is used for the entire hole. At shallow depths the coupling-driven pump is not delivering horsepower because of the inability of the pump to speed up and circulate more fluid against a higher pressure.

standing by the fact that it is a torque multiplier. It adjusts the speed ratio and torque for each stand of pipe and thus does the overall job faster than any other type drive. During the high speed hoisting it also has the ability to shift speeds during the lift so as to first overcome the inertia effects and later to use the entire engine capacity to complete the lift.

2. Drive the rotary. In this case, horsepowers are of little significance because the total requirement is small and the characteristics of the drive are more important. During the introductory period of converters there were some who felt that because of

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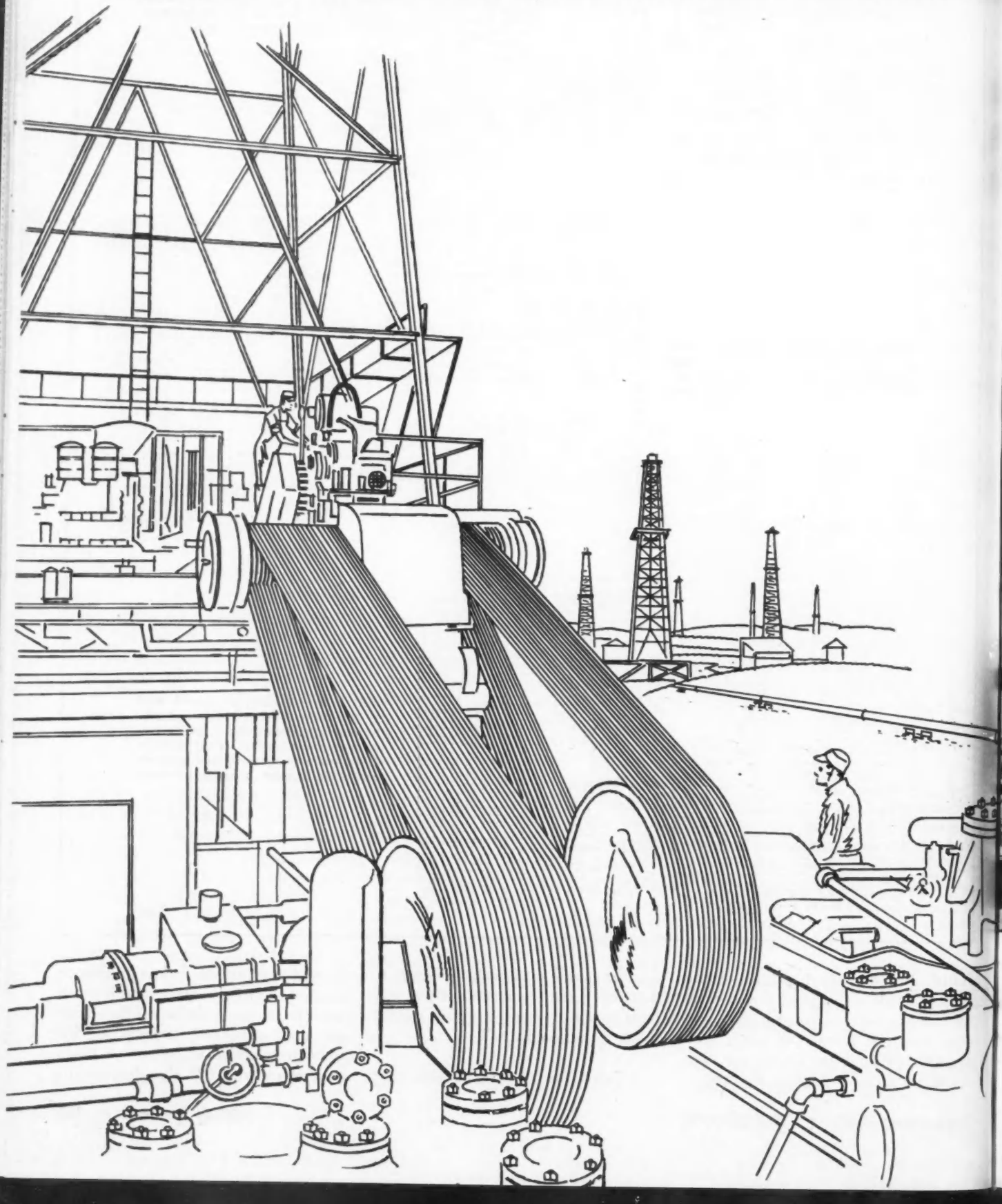

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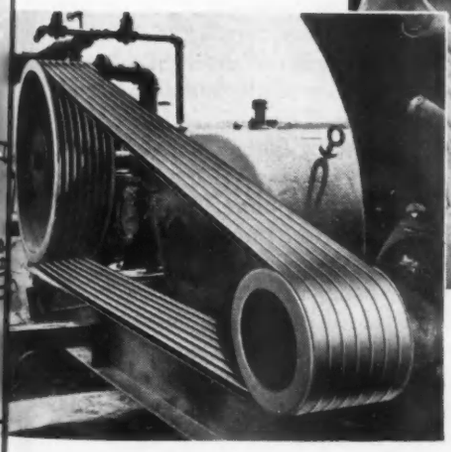

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the torque multiplication there was always a potential danger of twisting off pipe. It has been found, however, that converters in addition to their very excellent speed control to rotaries adapt themselves very well to the torque demands. This is because they give the operator a very excellent signal that his pipe is stuck by the manner in which they slow down the rotary speed.

3. The third function on a drilling rig is driving the pump. This is more controversial. To aid in the understanding of a comparison of couplings and converters, a separately driven pump has been chosen so that the problem involves a definite engine horsepower and pump capacity.

Figure 20 illustrates the instantaneous hydraulic horsepower values by these two types of drives. On this figure every advantage has been given to the coupling driven rig. Liner sizes have been changed in half inch increments as frequently as necessary and also bit jet sizes have been changed to make the power absorption of the well system most adaptable to each liner change. Incidentally, the selection of liner sizes and jet sizes is not a simple matter and it requires a considerable amount of time of a trained person to make these selections properly. These conditions are in contrast to the single liner size and single jet size, which were selected for the converter driven pump.

For surface conditions it was simply assumed that two pumps would be available and could be used in parallel while drilling the big diameter hole.

The well conditions were established as a 9⅞-inch hole below surface drilled with 4½-inch full hole drill pipe and with 200 feet of drill collars.

Under these conditions the hydraulic coupling was able to deliver an average horsepower of 482.1 in the small hole as compared to 464.7 for the converter driven pump. In the surface hole the two converter driven pumps were able to deliver as much as 923 average horsepower while the hydraulic coupling could only deliver 822. This demonstrates the ability of the converter to adapt itself to rapidly changing conditions as they occur in the surface hole and accomplish a materially greater job.

This comparison has been made with the most favorable conditions for the coupling driven pump and the gain in the main hole in horsepower was only 4 percent.

The remaining portions of this figure compare the fuel consumption of these two drives, the annulus velocities, the jet velocities, the pump pressures and speeds.

Probably a more applicable comparison is shown by Figure 21. In this case the same engine, pump and hole conditions are used and the only difference lies in the number of liner sizes used on the coupling driven pump. The liner sizes and bit jets were carefully chosen, but the liners were limited to two sizes.

Again the converter showed a material improvement in delivered horsepower in the large surface hole. However, this should not be overemphasized as the surface hole generally drills very rapidly and the total time difference, in hours, would not be too great. In the main hole, however, the hydraulic coupling delivered an average hydraulic horsepower of 465.3 as compared to the average horsepower of the converter of 464.7 which for all practical purposes is the same performance. It could be concluded that for the normal pump operation the two types of hydraulic drives will accomplish the same amount of work for normal pumping operations. The converter will gain favor in that it has greater flexibility for emergency operations.

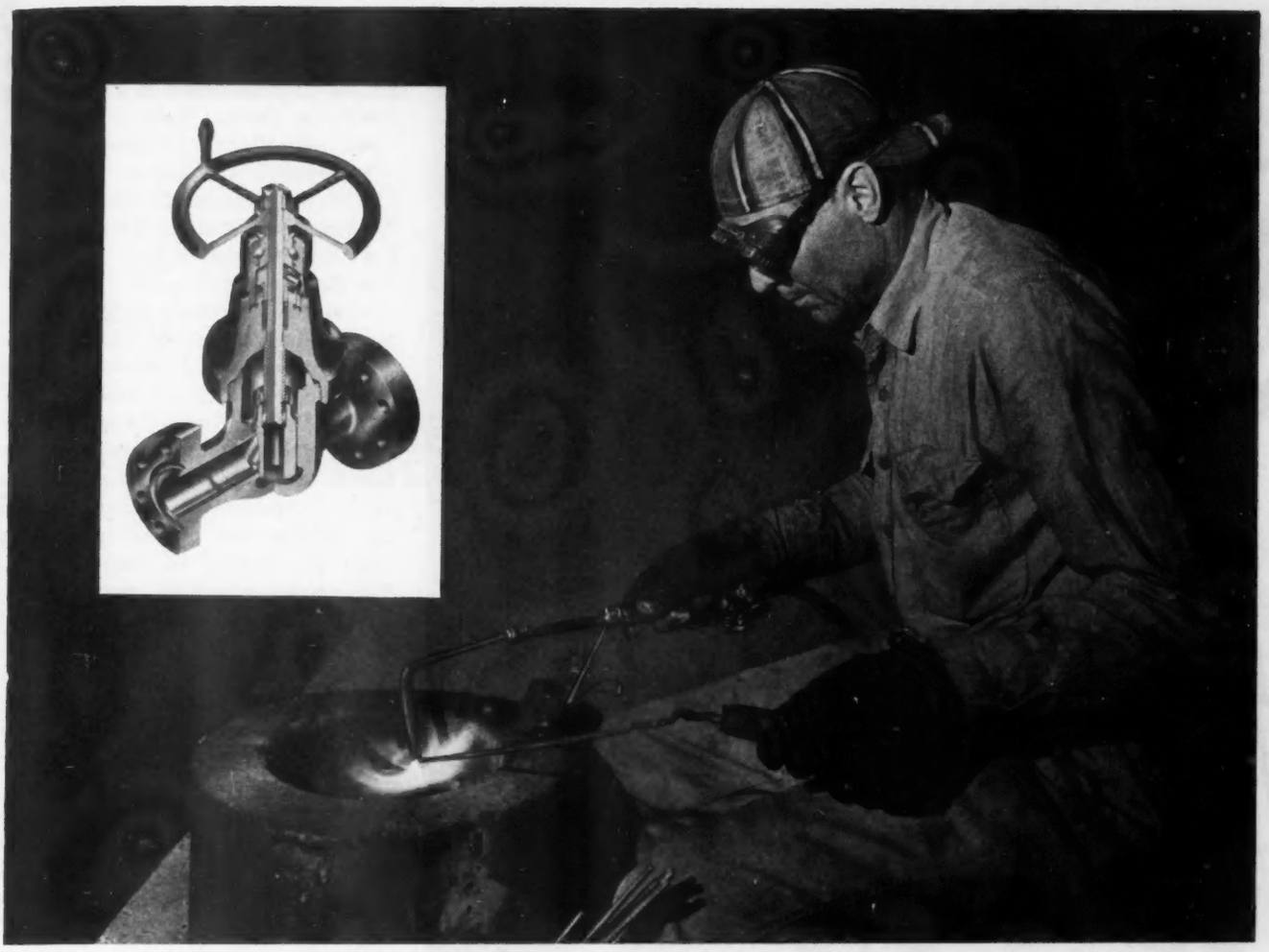
There are many pumping operations where the wrong size liners are in use which would seriously reduce the amount of horsepower being delivered by the coupling driven pump, this condition would have only a very slight effect upon the horsepower delivered by the converter. The converter driven pump would also have the advantage of giving the operator an immediate signal of a wrong size liner in that it would be running either too fast or too slow for good pump operation. With a hydraulic coupling driven pump, or a mechanical driven pump, there are portions of the time in which this cannot be readily understood.

Under this condition, which has been assumed to be average for pump operation, the converter will use from 4 to 5 percent more fuel, this is an economic disadvantage, but is easily offset by the economic saving brought about through fewer liner sizes. This not only reduces the necessary inventories on a rig, but it also allows the operator to completely use a liner or piston. It avoids having to put a partially used liner or piston into storage where it can be ruined by rust or abuse.

It is not always true that a converter driven pump can get by with one liner size. In the case chosen only one liner size is required even to a depth of 15,000 feet. One reason for this is that with the introduction of jet bits a large amount of the hydraulic horsepower has become fixed and is the horsepower in use at the bit so that the difference in pressures between the surface and bottom hole conditions is greatly different today from what it used to be. The pressure at 15,000 feet in this example is only 30 percent greater than the pressure at the start of the small hole at 3000 feet.

A third comparison, illustrates a misapplication of the hydraulic coupling driven pump and is included principally because of its academic value. The use of a wrong size liner is not unusual and can be equally bad. In this particular comparison the converter still is delivering its hydraulic horsepower of 464.7 as compared to the coupling delivery of 434.3, in the small diameter hole. Here it is easy to see why the less mechanically efficient device is accomplishing a greater amount of work. At only one point in the small diameter hole is the more efficient device able to function in its proper manner. At lesser depths the coupling driven pump is not delivering horsepower because of the inability of the pump to speed up and circulate more fluid against a higher pressure. The resulting horsepower is less than that delivered by the more flexibly driven converter driven pump. Immediately after this point has been reached the volume being circulated will tend to create too much pressure and torque for the engine and coupling to maintain its speed. From this point on down the hole the engine is simply unable to deliver its full amount of horsepower.

In conclusion, keeping all factors in mind, both types of hydraulic drives perform an excellent job, but the trend would be toward torque converters because of their economic values and flexibility. —**The End**



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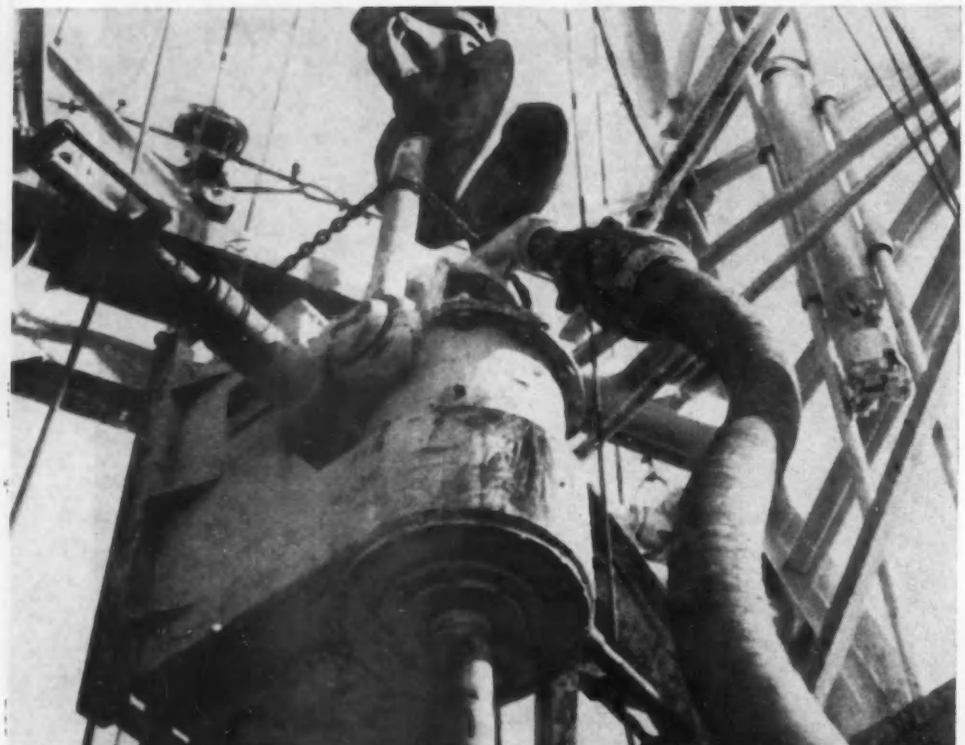


FIGURE 1—Power swivel—here power mechanism is incorporated into swivel. Note torque arms at each side. This unit is coring near Calgary.

What's New in Canadian Drilling Rigs?

Equipment designed to combat extremely cold climate and rugged terrain is revolutionizing rigs in the cold north.

By F. M. VALINT, Drilling Superintendent
Hunter Drilling, Ltd.
Calgary, Alberta, Canada

IN THE PAST, there has been very little thought given in Canada to drilling improvement or the designing of equipment for adaptability to the local climatic conditions. However, in recent years, there has been a definite trend toward this goal with some very surprising results. Numerous engineers, representing some of the best known manufacturers in the U. S., are showing more than just a mere interest in these Canadian designs and techniques.

To be more specific, let us examine the better known and more widely adapted equipment which is designed and/or manufactured in Canada:

- Power Drilling Sub
- Crown Block Protectors
- Engine Safety Alarm
- Engine Emergency Shutdown
- Improved Drilling Feed Control
- Mud Suction Valve
- Mud Level Alarm
- Hydraulic Rotary Table Drive
- Wellhead Swabbing Valve

The prototype of the drilling sub was designed and manufactured in 1954. It was a form of hydraulically driven power swivel designed primarily to provide a rotating mechanism for the drilling string for service rig workover operations such as cleanout, drilling of retainers etc. This workover tool, in comparison to any power swivel previously designed and manufactured in other areas, incorporated considerably larger capacity both in speed and power as well as the ability to operate over longer periods of time without heat generation.

Shortly after this tool had proven successful on a number of workover operations, a major oil company engineer saw the possibilities of its use in overcoming the problem of diamond coring in the Pembina area. Coring in this area was proving to be most difficult and costly. Due to the character of the formation from surface to the top of the producing zone in Pembina, a considerable amount of bit tooth breakage was experienced when economic rates of penetration were attained. Numerous junk basket and magnet runs were necessary to obtain any reasonable degree of safety in prevention of damage to the expensive diamond corehead. Even after reasonable care was exercised in removing all small iron from the hole, occasional corehead damage was evidenced. This problem primarily arose when taking the usual 50-75-foot core, one or more connections were necessary. This permitted iron to fall to bottom which was impossible to circulate away from the corehead due to the lack of annular space.

The major oil company's engineers thought that, if the necessity for pulling out of the rathole could be eliminated, damage to the diamond corehead could be reduced to a minimum. Therefore, by joint agreement with this company and the manufacturer,

it was decided to design and build a power swivel of sufficient speed and power to drive the drilling string for diamond coring operations. This power drilling swivel was designed to have an ultimate torque of 4700 foot pounds and a maximum speed of 115 revolutions per minute. Upon completion of the swivel, thorough tests were conducted for torque rating and speed. The first test consisted of rotating the drilling string at 8650 feet with the swivel hanging from the blocks. The two torque arm guide lines were tightened and the speed control valve was opened slowly. The string was turned at approximatley 30-35 rpm and then gradually increased to 100 rpm. The bit was then put on bottom and weight increased to 40,000 pounds. The lack of effort required to rotate the drilling string with the power swivel, regardless of the high weight on bit, was remarkable. The second test comprised the taking of a 36-foot continuous core. When starting with a slow speed of rotation a considerable amount of torque was developed. This was evidenced by the extent of the whipping of the torque arms. By increasing the rotary speed to the range of 80-85 rpm, this condition was completely overcome and coring operations proceeded in a routine manner. The core was cut at a rate of 15-20 minutes per foot at the beginning and gradually increased to 8-10 minutes per foot.

The power swivel was then sent to the Pembina oil field for testing on operations for which it was designed. On the third job in that area, the last rock bit, before core point, showed 60 percent tooth breakage. Under normal conditions, this would have necessitated numerous magnet runs. In order to prove the theory, the customary magnet run prior to this operation was eliminated; the core barrel was run in and with the core bit approximately one foot off bottom, the hole was circulated for a period of 10-12 minutes with pump pressure of approximately 800 pounds per square inch. After circulation the corehead was immediately placed on bottom and the coring operation commenced. When the top joint was drilled down, the slips were set and connection made with no breakage to the core, nor pulling off bottom. This procedure was continued until a total of 68 feet continuous core had been cut. On pulling the corehead, examination showed no signs of damage whatsoever. 100 percent core recovery was effected.

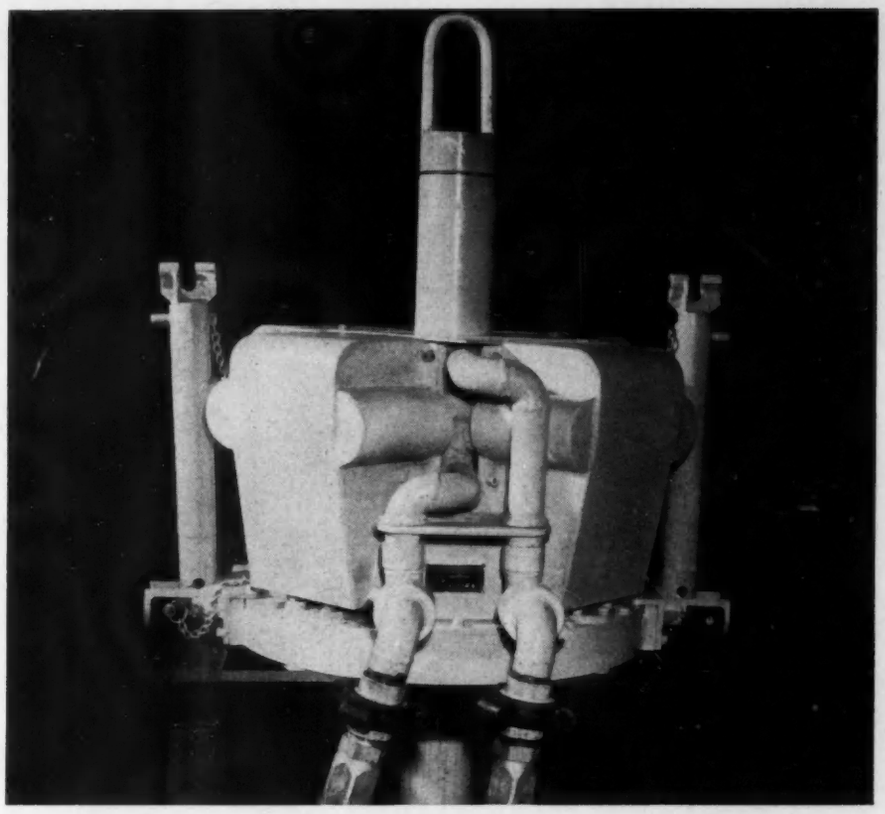


FIGURE 2—Power drilling sub that connects to the swivel rather than incorporated into the swivel.

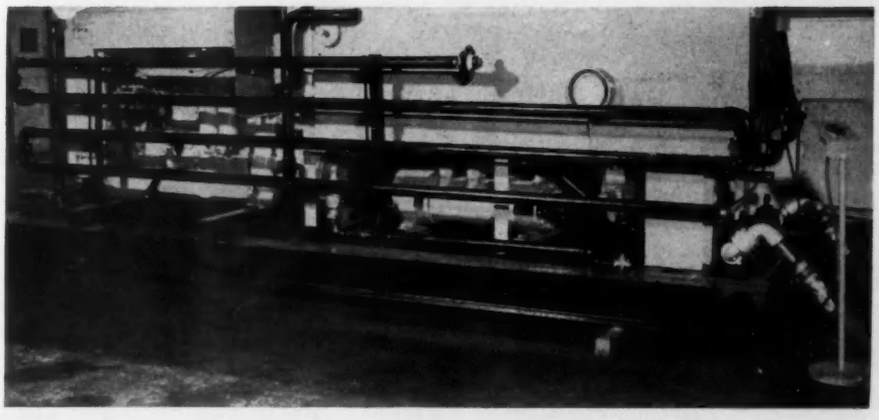


FIGURE 3—Hydraulic pumping unit for supplying power to power swivel.

After this test was conducted in Pembina in June 1955, the method was established as standard procedure for diamond coring by the company. To date, on all wells cored by this method, damage to coreheads due to iron has been eliminated.

Because of the volume of work in this area, it was necessary to manufacture a secnod unit. After experience with the original service rig model power drilling swivel and the second larger power drilling swivel, a distinct improvement in the original design was made. The second unit manufactured for the Pembina area was a power drilling sub connected to the swivel rather than incorporated in the swivel within the rotating mechanism. The achievement of compactness, the streamlining of the whole unit, elimination of a considerable amount of weight, and bal-

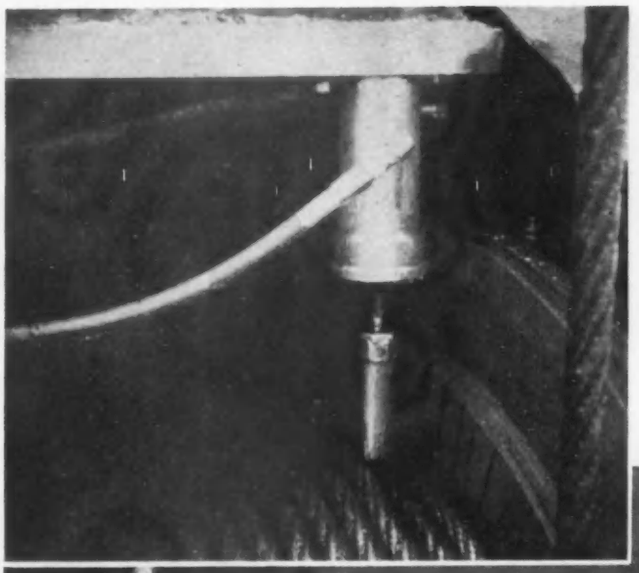


FIGURE 4—Crown block protector installed on drawworks. Number of wraps of the drilling line actuates the clip valve to disengage clutches and apply brakes.

FIGURE 5—Emergency shutdown for engines is of the concealed sliding gate type. This device prevents engines from running-away due to gas flooding.

anced tool which was easier to handle in rigging up, were the principal advantages of this sub over the swivel.

The evolution of the power drilling sub from the original work-over model power swivel was strictly a Canadian development. Since the successful development and operation of the power drilling sub in Canada, it is now being manufactured in California to the basic designs originally developed. Two sizes of this unit are currently being produced in California, one designed specifically for service rig operation and the larger designed for offshore drilling from barges on the California coast where wave action creates a serious problem due to swaying of the mast while kelly and rotary table are rotating drilling string.

An additional important application for the large power drilling sub has developed. The Union Oil Company of California, operating in Alberta, was faced with the problem of drilling a foothills well on a location necessitating a spud-in on rock outcrop having no overburden. In order to supply sufficient weight on bit to drill with any reasonable rate of penetration, two 9-inch drill collars were used to spud, driven directly by the power swivel. The hole was drilled in this manner to 78 feet with a much higher rate of penetration than would be possible with use of a kelly. After this short surface hole had been made, conventional drilling methods was used.

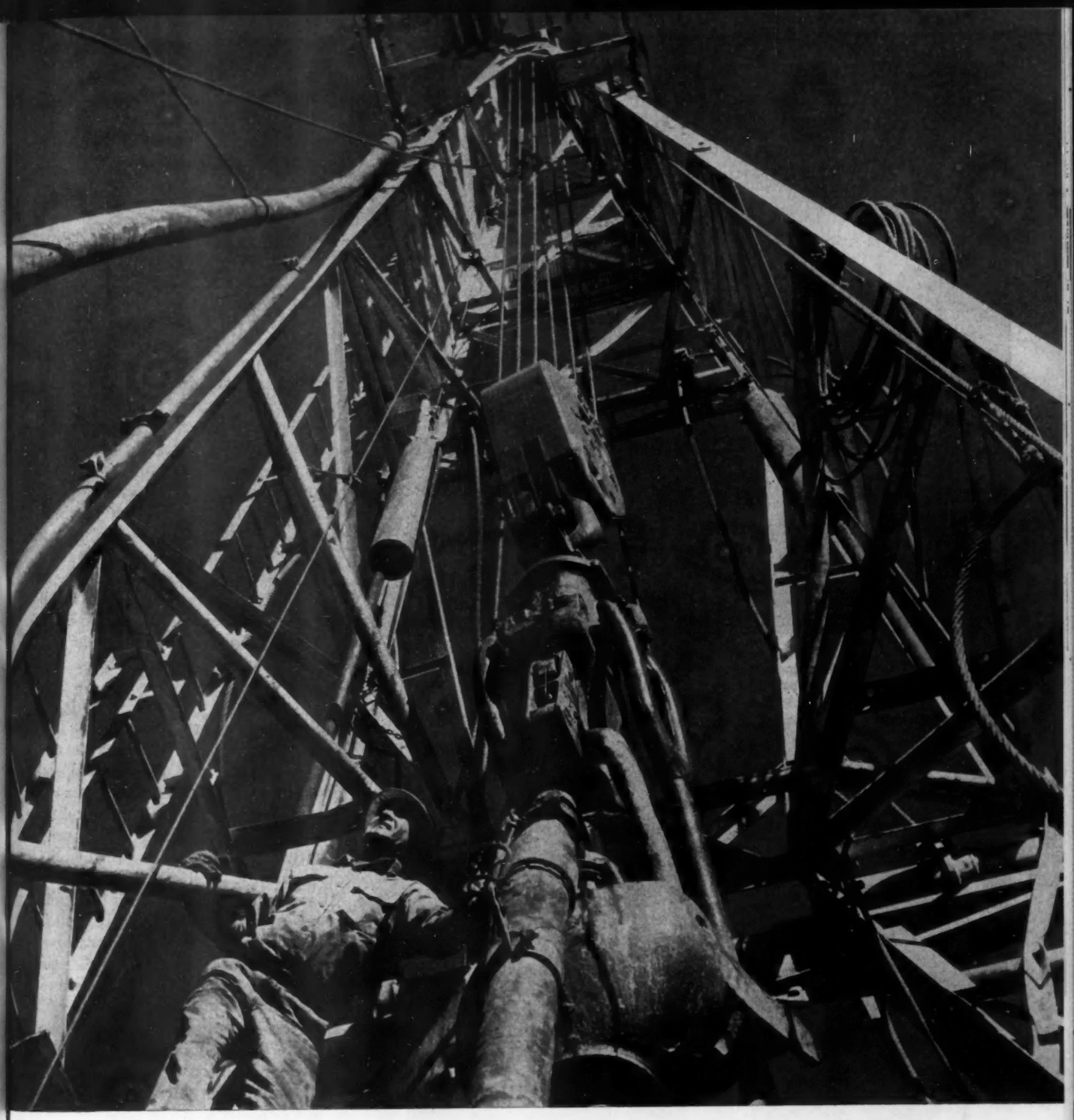
Crown-Block Protectors. The crown-block protector which is a logical answer to the persistent problem of accidents caused by running into the crown. This ingenious device will apply the drawworks brake and disengage hoisting clutches by actuating a specially designed clip valve mounted on the drawworks immediately above the drum. This clip valve is actuated by contact with the drilling line as it spools at a predetermined safety point.

A completely different approach to this problem is still in the development stage and has not as yet been tested in the field. However, it will be attached to a rig in the very near future where it will receive thorough tests. Details of the design cannot be divulged at the present time. However, it can be stated that it will be located and actuated from the drawworks and will not involve the mounting of actuating devices high in the derrick at an inaccessible spot. This has been one of the principal disadvantages of previous attempts to develop a fool-proof safety device to prevent running into the crown.

Engine Alarm. Ideas are born from experience and it was a Canadian oil field mechanical superintendent who applied his experience to an idea and the engine alarm was conceived in its original form about six years ago.

Primarily, the basis for design was a unit to give complete automatic

throttle shut-down and declutching



Wire Rope at Work—Out on the plains of Kansas, the Shields Drilling Co. was making hole fast when this photograph was taken. Drilling had progressed to approximately 3000 ft, with an ultimate depth of 4200 ft in prospect. The rig in the picture was a veteran, one that had logged a lot of hole; it had drilled some 300,000 ft in a period of four years.

On this particular job, the rotary line was Bethlehem 1-in. 6x21 Seale, Purple Strand grade. It was the latest of several Bethlehem ropes, all of them excellent performers. Careful, detailed records showed an average of 16 wells per Bethlehem rope; or in terms of ft, 50,000 to 60,000 ft of hole drilled per rope. This is the sort of consistency that users like, and it is always particularly pleasing when costs are figured.

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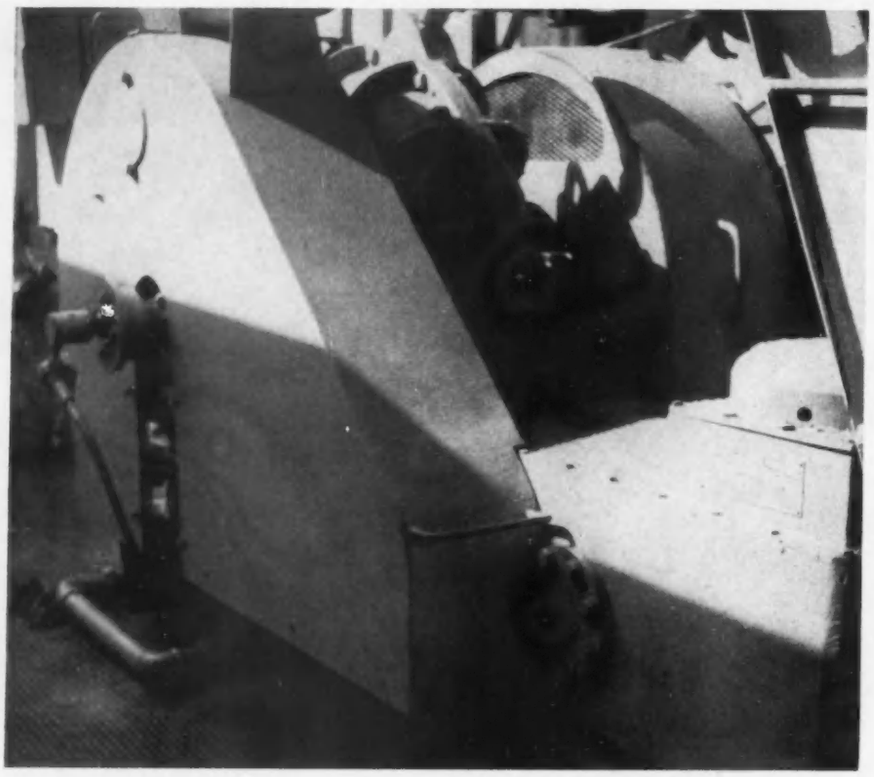


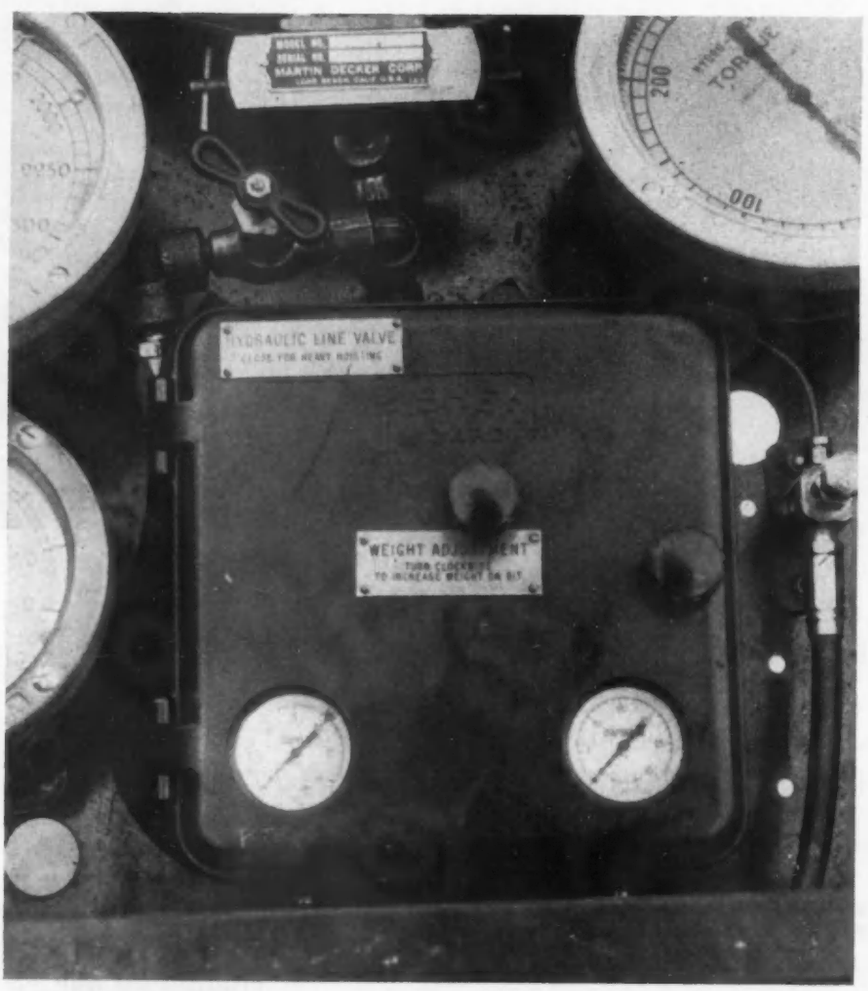


FIGURE 6 and 7—Drilling feed control. Figure 7 shows a close-up of the controller mounted on driller's instrument panel. Center knob is used to adjust weight on bit.

throttle shut-down and declutching control for high coolant temperature and low oil pressure on drilling engines. The several requirements to be incorporated in the design were:

- Simplicity
- No electrical circuits
- Vibration resistence
- Interchangeability between engines
- Minimum of line connections
- Ease of field servicing

Compressed air was the source of actuating power.

The original engine alarm was made up in several sections, each coupled to the other through hoses. This prototype unit had been tested and modified in the field for almost a year. Improved design incorporated all the separate sections in one body, eliminating the external hose connections. By using balanced air pressure, O-rings and springs, the wear of parts due to engine vibrations was eliminated. All valve action and seals are accomplished with rubber-to-metal contacts, thus avoiding lapped metal-to-metal seats.

Engine Emergency Shutdown. The emergency shutdown idea was started about two years ago after several engine runaways resulted from natural gas flooding. Common practice originally involved blocking air intake parts with damp rags to prevent engine runaway.

Later types of shutoff used butterfly valves in the engine air intake manifold. This type of cutoff did not prove satisfactory since it restricted the air passage and did not provide positive and obvious indication of position.

The normal engine vibration wore the butterfly gate spindle bearings. On large engines the gate valve was practically impossible to install, because of space limitations. Sealing of the butterfly plate proved difficult.

A new design, the concealed sliding gate type, was then designed which gave free air passage. A larger spindle could be used because it did not restrict the air passage. Closer tolerances could be held in the gate and body; insuring complete cutoff. The installation was easier and cheaper and remote control of the emergency shutdown was simpler to install.

Since the original emergency shutdown was first made about two years ago, it has had little change in its basic desgin, except for the use of re-

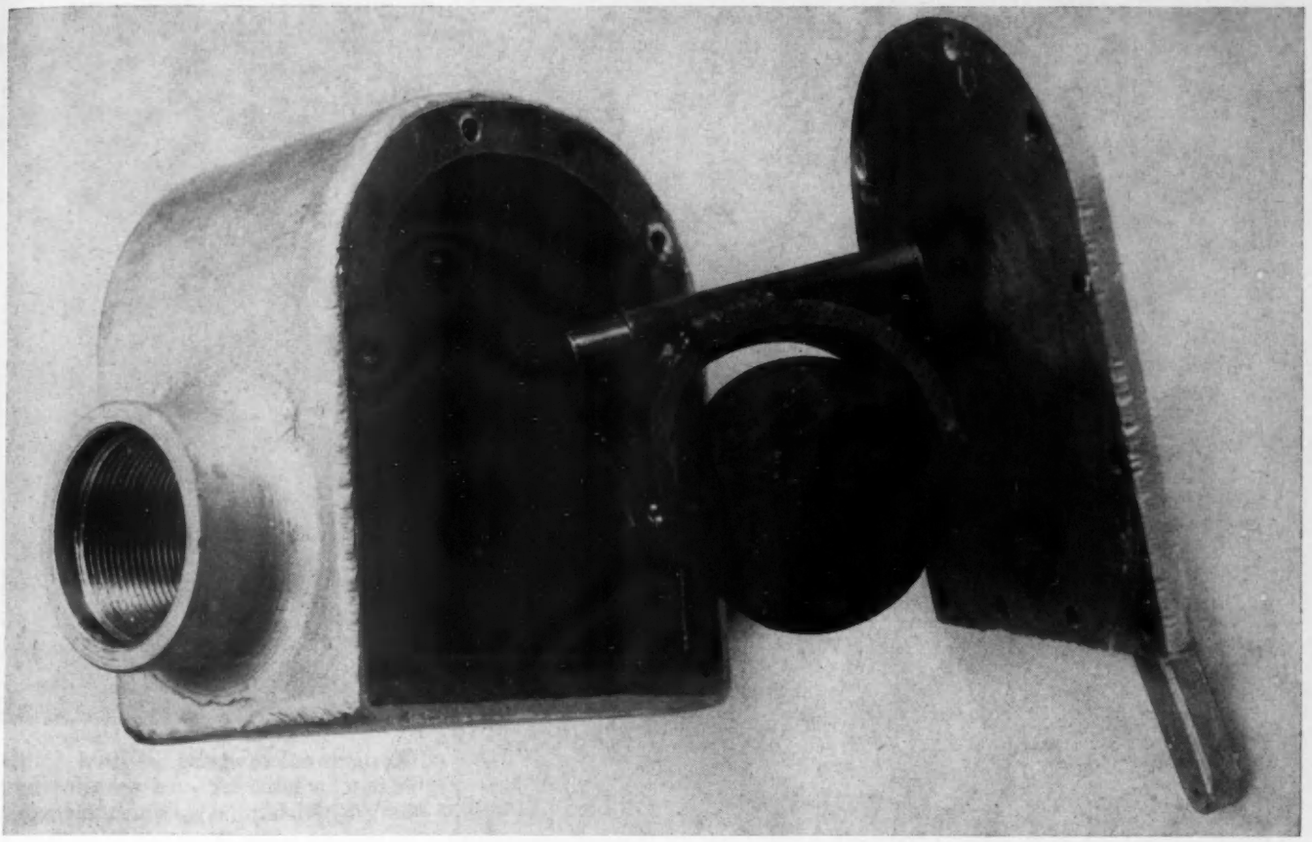


FIGURE 8—Wellhead check valve consisting of a 4-inch diameter neoprene ball mounted on an eccentric arm which enables the operator to place the valve either in the open or the closed position.

sistant material and further spring loading to reduce movement caused by engine vibration.

Models have been installed on most standard types of engines and basic models with adaptation have been placed on many others.

The problem of runaway engines has become so prevalent in some areas that drilling contractors are required to have an emergency shutdown device on their engines before being allowed on a lease.

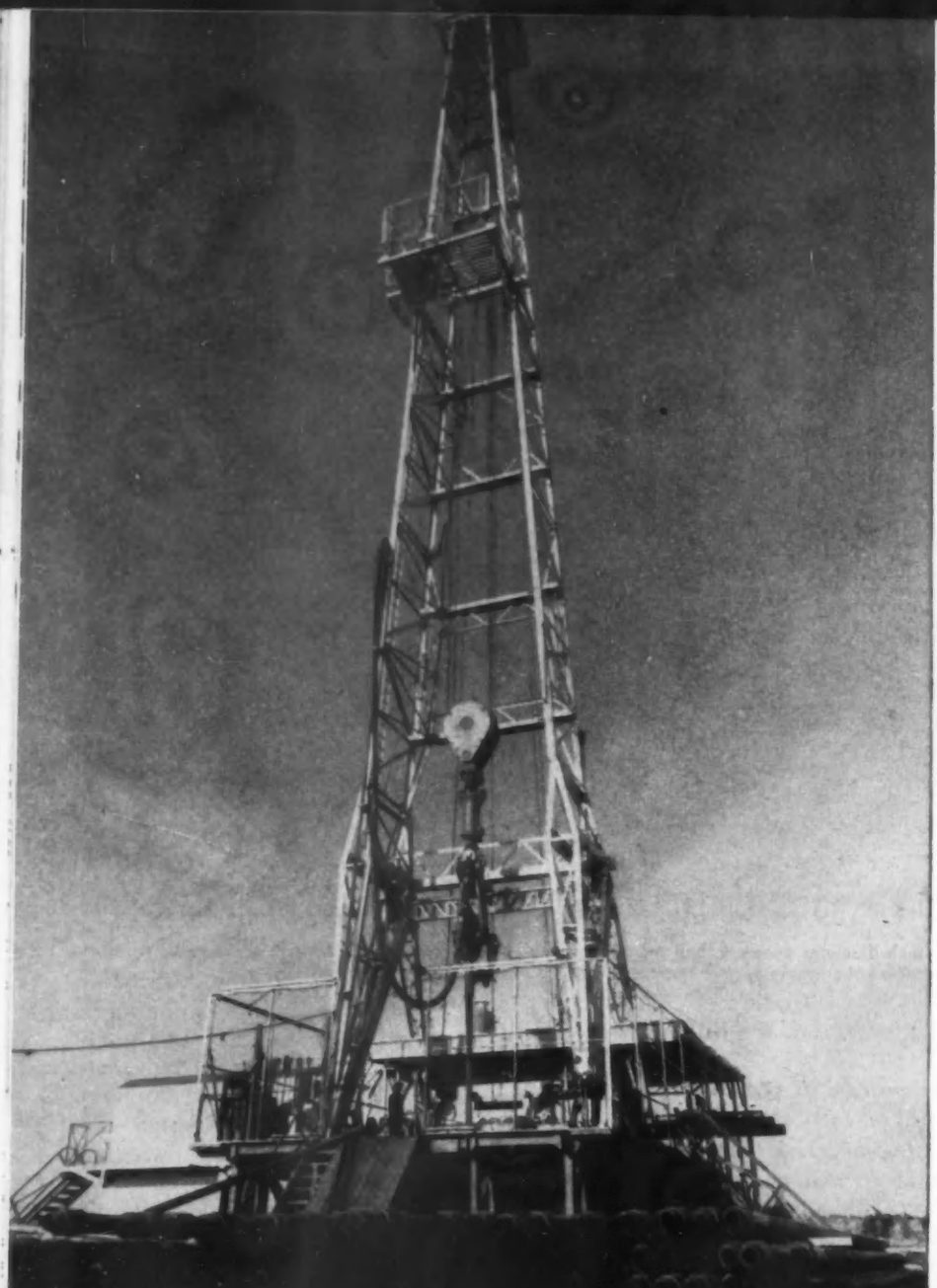
Drilling Feed Control. This very compact drilling feed control, which was actually designed in Trinidad, was tried both on power and steam rigs with great success, but was not perfected for cold weather operation. A prototype model was built in Edmonton and installed on a major oil company rig where the details were worked out for adaptability to the severe climate of the country. The unit consists of a specially designed speed increaser, a hydraulic positive action pump and air-operated valve, safety device, and a controller mounted at the driller's position. It was connected either to the weight indicator or a diaphragm on the drilling dead line.

Sequence of Operation. When the drilling feed control unit is put into operation, the driller places the bit as close to bottom as possible. The hydromatic clutch and the feed control clutch are engaged and the brake is raised slowly until the feed control holds the weight or drill string. The feed control clutch is actuated by an air valve at the driller's position. After the brake is raised, a second air valve is turned on which extends a finger attached to an air cylinder. The brake handle is rested on this finger and a weight hung on the brake so that, when the finger is removed, the weight will apply the drawworks' brakes. Adjustment of the predetermined weight, by means of a knob on the controller, is made until the desired weight on the bit is established and then is hung on the safety device pin.

The sensitive controller now takes over and maintains the weight on the bit within 1000 pounds, regardless of changing formations. As the required weight is reached, the pressure in the diaphragm, or sensator, is dropped proportionately. The borden tube in the controller assumes a new position and allows the air from the valve diaphragm to escape and the spring starts closing the valve. As the valve starts closing, pressure begins to build up between valve and pump. The pump is slowed down and, through the speed reducer, retards the unwinding of the drilling line on the drum. This slowing-down effect on feeding off allows the weight on the hook to increase.

In turn, this increases the diaphragm pressure to the borden tube in the controller, closing the flapper valve, and allowing the instrument air to enter the control valve diaphragm, opening the control valve. The decreased pressure between pump and valve allows the rotary positive action pump to turn much faster. Hence, the line of the drum unwinds proportionately.

A valve positioner is attached to the yoke of the control valve. Being a very sensitive type of relay, it not only speeds up by many times the action of the control valve, but positions the control valve more accurately than can be accomplished by means of a controller alone. This eliminates hunting of the feed control and varying weight on bit, thus increasing the sensitiveness of the unit by a considerable



Designed for speed in drilling, this rig drilled 7,400 ft in 16 days at a location near Lindsay, Oklahoma. Carrying 40,000 lb of weight at the bit, it was pumping 641 gallons of mud a minute at 1,800 lb pump pressure to pulverize sand and rock and increase the drill's boring speed.

Power-Play For Oil

Mercury Drilling Company—searching for new reserves —uses one of the most powerful rigs ever built to thrust Pittsburgh Steel Company drill pipe into the earth.

Packing all the controlled power of a diesel locomotive, Mercury Drilling Company's Rig No. 2 is a giant among the nation's rotary drill rigs. This herculean rig, with its 142-ft high derrick now working in the oil-laden Golden Trend sands of Oklahoma, can bore its jet bits into the earth at rates up to 1,000 ft a day. It can bullseye a one-foot diameter target more than three miles underground.

Roughnecks stab the tool joint into the waiting end as another length of drill pipe goes into the hole.

Equipped with three 870 hp engines and three of the largest torque converters built, it can supply more than 2,400 hp to drive the rotary table and mud pumps. Its block, weighing nearly 8 tons, was specially designed for the rig.

Compact design throughout and a portable mud tank system give the rig mobility. On completing a hole, it can be knocked down, transported to a new location, set up and be drilling again in less than 2½ days with favorable weather.

When you have an investment of over a half-million dollars and operation costs up to $1,000 a day on a rig such as this, you can't afford to waste time.

Every feature of Mercury No. 2 is built for speed. From the power needed to carry heavy bit weight-loads, to the automatic slips for going in and out of the hole, it is equipped to drill more footage faster and more efficiently. Its mobility reduces down time between jobs.

Quality of the equipment and swift supply service are also essential to reaching pay fast. Here again Mercury saves time and expense.

This rig with all its equipment —including Pittsburgh Steel Company's seamless 4½ in. OD

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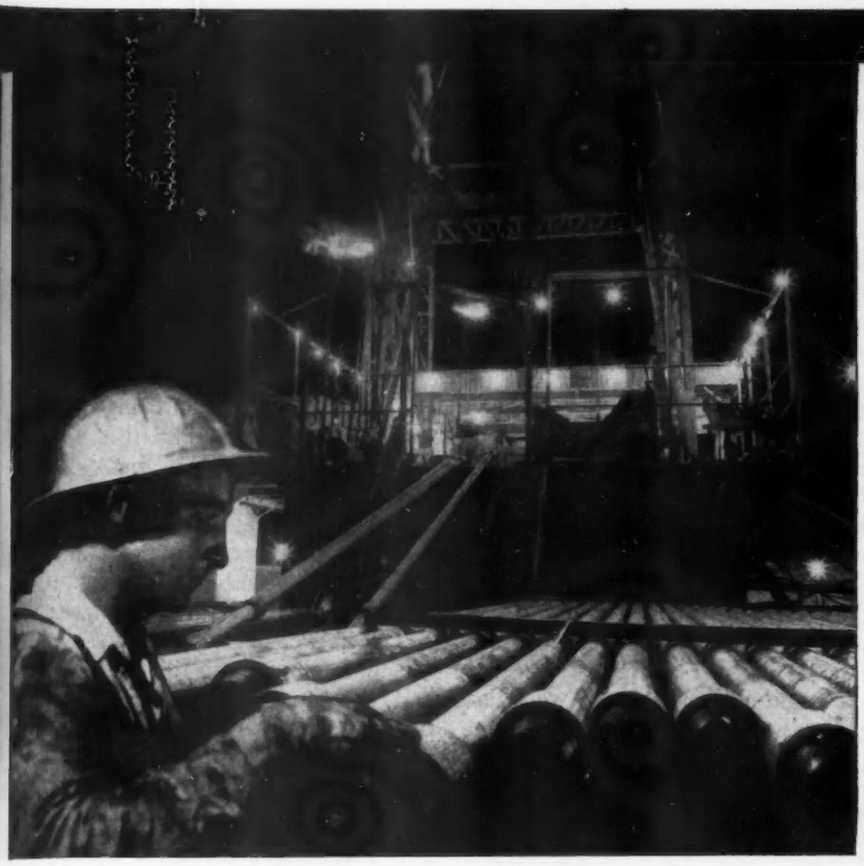

Drill pipe, being measured in the rack, is fed into the hole length by length as the hole deepens. On a rig such as this it must withstand severe tension, compression, torsion and fatigue stresses as well as abrasive wear.

Grade E Range 2 drill pipe—is supplied by one of the independent distributors listed at right. Already a pace setter, it is hungrily churning after new footage records.

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Independent distributors are ready for action. Even the smallest item of equipment is available to your rig 24 hours a day, seven days a week. Well-stocked supply stores mean equipment can be on hand at the rig with least delay. You can count on them in emergencies.

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Independents are accessible. The distributors at right have 141 stores covering all major oil fields in this country and some abroad. Yet each distributor individually concentrates his services in the home areas he is best qualified to serve.

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degree. The increased speed of action which has been obtained by the use of this device creates an important advantage, particularly when drilling in alternating hard and soft formations.

Many drilling feed controls of the older type had a tendency to feed off a considerable amount of weight on bit over the determined weight when suddenly drilling into hard formation from a very soft one. The extreme rapidity of reduction in feed-off of the drilling string, created by the use of the valve positioner holds this increase to an absolute minimum when this condition is encountered. It therefore, eliminates this problem which is prevalent with manual drilling or with the older types of drilling feed controls. Damage to bit teeth and bearings is reduced to a marked degree.

A safety device is incorporated in the unit, eliminating the possibility of an accident through any mechanical failure and allowing the weighted brake handle to descend, immediately applying the drawworks' brakes.

Mud Suction Valve. It was the request of a drilling superintendent that the mud suction valve was originally designed. A request was made for a mud valve for Western Canadian use, which would include the following design features:

- Resistant to frost damage
- Pass solids without clogging
- Full opening
- Installed by welding
- Positive indication of open or closed positions
- Rugged construction
- Corrosion resistant
- A valve which would split, eliminating unions.

Because there is little pressure on mud suction lines, the open type valve was decided upon. This same feature made it a union. The gate, swinging between the two-section valve body and fitted with positive stops, provided full open or positive shutoff positions.

The steel body castings are machined for a socket fit on the pipe. A cadmium-plated steel gate, swinging between standard mud pump valve cover gaskets, provides a leakproof and corrosion-resistant combination.

Mud Alarm. With the increase in mud circulation volume in the past few years and with little increase in mud storage volume, the need of an accurate pit level indicator became imperative.

The float control type of unit had been used for years, but it was found that this type would "cake up" and lose its sensitivity or become contaminated with added chemicals. The methods of setting these types of level indicators were usually fairly inaccurate.

Standard air operated alarm parts were incorporated into the mud alarm using a large oil resistant rubber diaphragm and corrosion resistant parts for actuating the alarm. Several units of this basic design were sent to the field for testing two years ago.

It was found that the unit could be set to register drops of one-half inch in mud level and that the diaphragm was not subject to corrosion from chemicals. Since the diaphragm is horizontally positioned under the alarm housing, caking has not been a problem.

A half-inch chain provides a support and level adjustment for raising or lowering the mud alarm in the tank in half-inch increments. This proved to be accurate enough for general use and the same system is used in present models. Compressed air is used as an operating medium in the mud alarm. Hose connections are contained inside the swinging arm and are thus protected.

Hydraulic Rotary Table Drive. Although this unit has been in the throes of development for many years, it is just very recently that an actual prototype of the model has been completed and tried out on a major oil company drilling rig.

The hydraulic rotary table drive consists of a hydraulic positive action pump, driven from the rig compound by a silent chain, a hydraulic control valve, pressure relief valve, volume tank, hydraulic motor fitted on the side of the rotary table, high pressure 1¼-inch piping and chiksans.

As this hydraulic pump is a variable delivery type, the absence of heat generation due to the elimination of fluid bypass is one of the most attractive features of the unit. The pump operates at all times, except when making trips or during any lengthy shutdowns. In other words, the pump is set on neutral position when the table is not in use.

When drilling commences, the engines' throttle and pump delivery are set at the required rpm. One of the main features of this unit is the saving of constant operation of the drawworks, effecting a truly independent rotary table drive without bulk.

On rigs where the compound drives both ways, i.e., pump and drawworks, there is usually little or no possibility of suitably varying the table rpm to the particular formation being drilled, without having to change pump speed. Furthermore, on rigs with a limited power supply, this is a serious drawback, as calculations show that the drawworks on the 400-450 horsepower range absorb as much as 32-38 percent of the output horsepower.

The above unit was designed with a view to eliminating this power drag and giving a complete independent rotary table control. It also provided a saving of the constant wear and tear on the drawworks and, consequently, a reduction in fuel consumption. The unit also has a great advantage over conventional independent table drives due to its compactness and having practically no weight increase. A conventional independent table drive is an awkward, long and heavy unit, it cannot be used on a small rig.

Wellhead Check Valve for Swabbing Operations. A special valve for swabbing operations, to be attached to the top of the tubing string immediately below the oil saver. The valve can be closed immediately after the pulling of the swab tool. It is a swinging check valve consisting of a 4-inch diameter neoprene ball mounted on an eccentric arm, which enables the operator to place the valve very rapidly either in the open or closed position. Upon pulling the tools, it is necessary only to flip the arm, swinging the ball into place against a seat in the top of the valve and shutting off the flow of oil which so often occurs during swabbing operations, particularly when the well is beginning to surge. This valve is not designed specifically to hold back high well pressure since, under these conditions, the flow line is open and the protection of the blowout preventers or other valves below is available.

A prototype of this valve has been manufactured in Alberta and will be tested in the very near future.

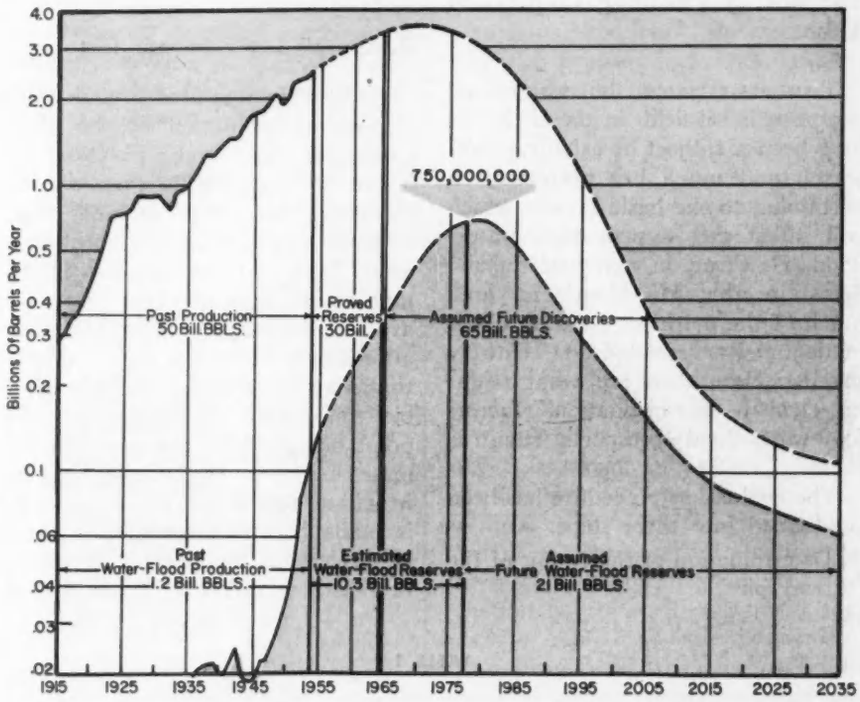
ACKNOWLEDGMENT

The writer wishes to express appreciation to Joe Blanchard of Alberta Oil Tool, Ed. Brennan of Barber Machinery, General Petroleums, Reading and Bates and J. Harris for their technical assistance and cooperation kindly rendered in the preparation of this article.

How Important Is Water-Flooding? . . . Let's Take a Look

ALBERT E. SWEENEY, Director Technical Services, Interstate Oil Compact Commission in Oklahoma City writes:

TOTAL ANNUAL production from water-flood operations in the U. S. has increased over the past four years from 80 million barrels to approximately 130 million barrels. Using the past history of water-flood production, a predicted curve for the future water-flood production has been prepared. A maximum peak of water-flood production of 750 million barrels annually is estimated for 1980, and a total water-flood production of 32½ billion barrels from all water-flood operations is predicted. Most of this future water-flood oil will come from Texas, Louisiana, California, Illinois and Oklahoma.



Computed Pattern of Crude Oil Production in the United States

Oklahoma—Water-flood production in this state currently accounts for nearly 14 percent of the total crude production. Water-flood production increased materially beginning in 1947. The production was increased substantially in 1951 when this method was initiated in fields outside of the northeast Oklahoma area. The application of water-flooding on a field-wide basis has been a large factor in this increase.

Kansas—Water-flooding was initiated shortly after passage of the law in 1935 legalizing such operations. The production from such operation has increased steadily since that time and is now approximately 12½ percent of total oil production.

Illinois—A phenomenal increase in water-flood production. Since 1950, the volume of annual water-flood production has almost tripled. The total production from water-floods in Illinois during 1955 has been estimated to have been 30 percent of the total production.

Texas—The volume of production from water-flood operations has increased from approximately 4 million barrels in 1950 to almost 30 million barrels in 1955. This 30 million barrels represents only 3½ percent of the total production in Texas. In other states, increases have also occurred so that water-flood production has increased considerably over the past five years.

Production personnel can not afford to overlook this phase of the industry. They must keep abreast of the improved water-flood techniques and equipment which parallel rising water-flood production. This collection of articles is designed to provide operating personnel and management an opportunity to become better acquainted with some of these techniques and devices.

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water-flood report
TECHNIQUES

Evaluation of Water-Flood Prospects

A reasonable estimate or an outright guess . . . which describes your water-flood?

By PAUL J. SHANOR
The Bradley Producing Corporation
Tulsa

THE EVALUATION of water-flood prospects in oil fields in the U. S. has long been a subject of exhaustive research and much has been written pertaining to the basic factors which will affect the success of a water-flood. However, in many of the old fields in the Mid-Continent area much of the pertinent data are either inadequately recorded or entirely missing. Here then are what might be termed "pre-evaluation" factors for water-flood prospects such as these.

The evaluation procedure has been subdivided into three steps:

1. Determination of the extent of the reservoir
2. Estimation of recoverable secondary oil reserves
3. Appraisal of economic factors

A list of factors used to arrive at a reasonable evaluation of the above categories has been prepared on Table 1. This list is certainly not complete, but does include many items that are available to most operators. Each of these factors is important emphasizing the fact that every available tool should be used in evaluation work. There are certain criteria that may be termed as the "irreducible minimum" of information—the point below which a reasonable estimate becomes an outright guess. Much of this minimum information is available, and the emphasis should be placed on the proper interpretation of these and other "obvious" factors. There is a fine line between the success and failure of a water-flood project, and as our hindsight has shown in a study of the failures, it is usually the obvious factors that have been overlooked.

TABLE 1

RESERVOIR CHARACTERISTICS	FLUID CHARACTERISTICS
Areal extent of reservoir	Oil saturation
Thickness of sand	Water saturation
Stratigrpahy and structure	Gravity
Depth to sand	Viscosity
Porosity	Chemical analysis of water
Permeability	Original and present BHP
Uniformity of sand	Original reservoir temperature
Shale streaks	Original and present GOR
Texture of sand	Capillary pressure
Amount of sand shot	Wettability
Clay mineralogy	Surface tension
PRODUCTION DATA	**ECONOMIC FACTORS**
Primary oil production	Development cost
a. Cumulative	Operating cost
b. By years by leases	Acquisition cost
c. BPA & BPAF	Plugged holes
Water production	Water supply requirements
Gas production	Water treatment
Initial production	Well spacing
Decline curves—type of drive	Equipment cost
Productivity indices	Salvage value
Accidental floods	Available power (gas or elec.)
Vacuum operations	Pumping problems (sand, paraffin, corrosion)
Previous water, gas or air injection	Topography
	Market for oil
	Taxes
	Proration

The factors shown in Table 1 have been separated for convenience into reservoir characteristics, fluid characteristics, production characteristics, and economic factors, although they are all somewhat interdependent. It is not the intent to discuss each of these factors separately, rather the "obvious" factors, the "irreducible minimums," some of the controversial factors, and some of the fallacies will be mentioned.

Reservoir Evaluation. The first step in evaluation is to determine the extent and characteristics of the reservoir. The areal extent and sand thickness listed under Reservoir Characteristics are two essential factors that can be considered "irreducible minimums." They can be readily determined from cores or electrical logs, but if it is necessary to rely solely on old well logs, care should be taken not to be too optimistic about the thickness of the sand body. The top of the floodable sand is usually lower than the top that the driller recognized, and generally the net sand will be 50 percent to 85 percent of the gross sand. This information is essential not only to determine the capacity of the reservoir by drawing isopach maps, but is equally important in preparing cross-sections of the sand body to be sure it is continuous. There have been many disappointing water-floods because of lack of continuity in a reservoir.

Another reservoir factor which must be considered is depth, although it is a limiting factor only if the sand is extremely shallow or extremely deep. While it is generally

true that the shallower the sand the lower the development and operating costs will be, it is a fallacy to assume that very shallow sands are the best prospects. The injection pressure at shallow depths may be restricted by the pressure at which the formation will separate or fracture at points of weakness.

There are some examples where sands less than 300 feet deep have been flooded but often the injection rate is too low for feasible water flooding, particularly those with unfavorable permeability and viscosity factors. The maximum depth limitation is still a moot question and seems to be a function only of economics. One of the deepest formations that has been flooded in Oklahoma is the Bromide formation at 11,000 feet in the North Lindsay field.

Two other important reservoir characteristics are porosity and permeability. Porosity is the dominant factor in determining the amount of oil in place, and should range over 15 percent. Permeability is more important for its uniformity than for its absolute value, since sands averaging from five to above 500 millidarcys have been flooded successfully. A permeability profile should be prepared if core analysis information is available. Porosity and permeability cannot be accurately determined without core analyses, and when cores are not available the best method to arrive at a reasonable estimate is to compare the sand in question with similar sands in the area. Initial production is sometimes used to suggest the variation of permeability throughout a given area.

Secondary Reserve Evaluation. The second step in evaluation is to make an estimate of the recoverable reserves expected by water-flooding. This can be done by considering additional factors listed under Fluid Characteristics and Production Data. The fluid characteristics of a reservoir are best determined from core analyses for they not only give us oil and water saturations, porosity and permeability, but are a valuable aid in predicting water flood reserves by laboratory flood-out tests.

The interpretation of certain core analysis data, particularly saturations, has been a subject of controversy for many years, but it is not the purpose of this discussion to present the various methods of core analyses. Let it suffice to say that anyone experienced in core analyses should be able to estimate the correlation between the laboratory data and the actual conditions in the field. Unfortunately, core analyses data are not available in most of the old fields in the Mid-Continent area.

There are, however, two important fluid characteristics which are readily obtainable. These are API gravity and viscosity. Again, these two factors limit a water-flood only if they are extreme. It is desirable that the API gravity of the oil be high and the viscosity low. Oils with gravities as low as 28 degrees have been successfully flooded in the Mid-Continent area but it is usually desirable that the gravity be above 32 API. The maximum viscosity of an oil which will respond to flooding has not been determined but the desirable values usually range to 20 centipoises.

About the Author

PAUL J. SHANOR is a petroleum engineer with The Bradley Producing Corporation and has been since 1953. Even before receiving his B.S. in petroleum and natural gas engineering from The Pennsylvania State University in 1948, he had been operating engineer with the Koppers Company from 1941 to 1944. After serving a two-year hitch in the U. S. Navy, Shanor became a petroleum engineer for Phillips Petroleum Company. In 1951 he was employed in the same capacity by Illinois State Geological Survey. He is a member of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., American Petroleum Institute, AAPG, the Engineers Club of Tulsa, and an Oklahoma registered professional engineer.

Production history is a valuable tool to evaluate water-flood reserves, and one of the "irreducible minimums" when core analyses are not available. The cumulative oil production from a given field can by itself serve as a guide for estimating secondary reserves. When using cumulative figures, the early production history must be obtained, for a large percentage of the oil is produced within the first few years. In general, fields that have had high primary recoveries can be expected to have high secondary recoveries . . . water-flood recoveries in the order of 100-200 percent of primary are not uncommon. The enthusiasm for high primary recoveries, however, must be tempered with a knowledge of the type of drive that produced the primary oil. The type of drive, i.e., gas solution; gas cap, or water drive can usually be determined from decline curves and other field operational history.

The most desirable reservoir to flood is one that was produced by the least efficient primary force—that of solution gas drive. The reservoir least desirable to flood is one which has been produced by water drive, although in certain instances it may be desirable to augment a natural water drive by artificial means. In utilizing production history, it is important that the information be obtained on a lease basis, as the individual lease performance may be masked when looking at the over-all field decline. Abnormally high primary recoveries should be viewed with suspicion since accidental flooding or water encroachment may have been the cause.

A lease decline curve will show how detrimental these effects have been, and will also show what effect air or gas repressuring have had on the property.

Economic Evaluation. The last step in the evaluation of a water-flood prospect is a critical appraisal of the economic factors. Unlike the previous factors that have been discussed, most of the economic factors are not a function of the history or past performance of the field, but are dependent on the operator's ability to predict future development and operating costs and consequently, must be based chiefly on experience. Development costs ultimately range from $1000 to $3500 per acre. Ultimate

operating costs per acre are generally the same or slightly higher than per-acre development costs. Operating costs toward the end of a water-flood operation will usually be 2 to 8 times the initial operating costs, ranging in the magnitude of 25 cents per barrel initially to $2 per barrel as operations approach the economic limit.

Although the economic appraisal is usually resolved into a problem of equipment selection and estimates of maintenance cost, there are several factors which are frequently underestimated or completely overlooked. One is the high cost of recompleting plugged and abandoned holes which are necessary to be used as either injection or producing wells. The poor condition of the hole and casing usually accelerates these remedial costs and in some instances recompletion is more expensive than new drilling. Where an abandoned well will not be used in the operation of the project, the replugging cost merits serious consideration, particularly if it was plugged prior to the jurisdiction of State regulatory bodies which govern plugging procedures.

Another development cost factor which is frequently underestimated is the cost of an adequate supply of water and the facilities for proper treatment. Many operators have been too optimistic about the source of supply that will fulfill their injection requirements. Injection rates in the Mid-Continent area vary from approximately one-half to one barrel per day per acre-foot of sand. Thus, it can be seen that the water requirements can be an item of considerable proportion . . . a 40-foot sand flooded on 20-acre spacing, for example, would require 800 barrels per day per well or 8000 barrels per day for 10 injection wells.

Water requirements in this magnitude cannot usually be satisfied by producing the "upper water sands" that appeared in the old well records as "HFW." Neither will the produced lease water, which seemed so voluminous as a disposal problem, add materially to an 8000 bpd requirement. Some areas are favored with nearby rivers and streams, and others have prolific water-bearing strata at a reasonable depth. Gravel deposits in Illinois have served as excellent acquifers for water supply. On the other hand, many areas are not favored with such low-cost sources of supply, and in some instances sufficient water can be obtained only from formations 3000 to 7000 feet deep. All possible sources of adequate supply water should be thoroughly investigated before the initiation of a large-scale injection program.

Proper water treatment is sometimes inadvertently neglected during the early stages of a water-flood project because the resulting consequences are not fully realized until a few years after the initial injection. Plugging and corrosion are two problems which may become more severe with time and are often encountered by the water-flood operator when it is too late to apply preventative or remedial treatment. It is imperative to constantly analyze the injected water and treat in accordance with the analyses. It is also advisable, prior to flooding operations, to secure and analyze samples of water produced from all formations in the field. This information will be extremely important if it is desired to determine the source or compatibility of extraneous water.

Summary. It should be emphasized that even though all the available factors are utilized in evaluation work and found to be favorable, there would be no guarantee that the water flood would be a success. There are still many controversial factors relating to evaluation whose roles are not fully understood. Furthermore, there may be certain physical and chemical properties, presently not recognized, that would influence evaluation studies.

In the last analysis, evaluation work is not infallible. At best it can only serve as a guide in deciding whether or not a water-flood project is feasible. If enough favorable factors indicate a good possibility of flooding, much of the inadequate information can be supplemented through exerience gained by the operation of a pilot flood. Also many operational questions such as spacing and injection rates can be answered. A pilot program will in most instances hasten the understanding of many problems prior to the operation of a large-scale development. —**The End**

water-flood report
TECHNIQUES

More Oil from Water-Flooding?

Recent techniques for increasing oil recovery in water-flooding may lead to more oil in the stock tank.

By DR. H. G. BOTSET
University of Pittsburgh

TODAY, WITH standard methods of secondary recovery, the residual oil saturation at the end of the recovery operation is from 25 to 30 percent of the pore volume. This represents a large amount of oil and the problem now facing the industry is to develop methods or procedures which will leave a lower residual at the end of secondary recovery, or which will permit a "tertiary" recovery of at least part of this residual oil.

There are two major approaches to the problem. One is that of increasing the efficiency of surface operations and mechanical procedures so that profitable operations may be continued

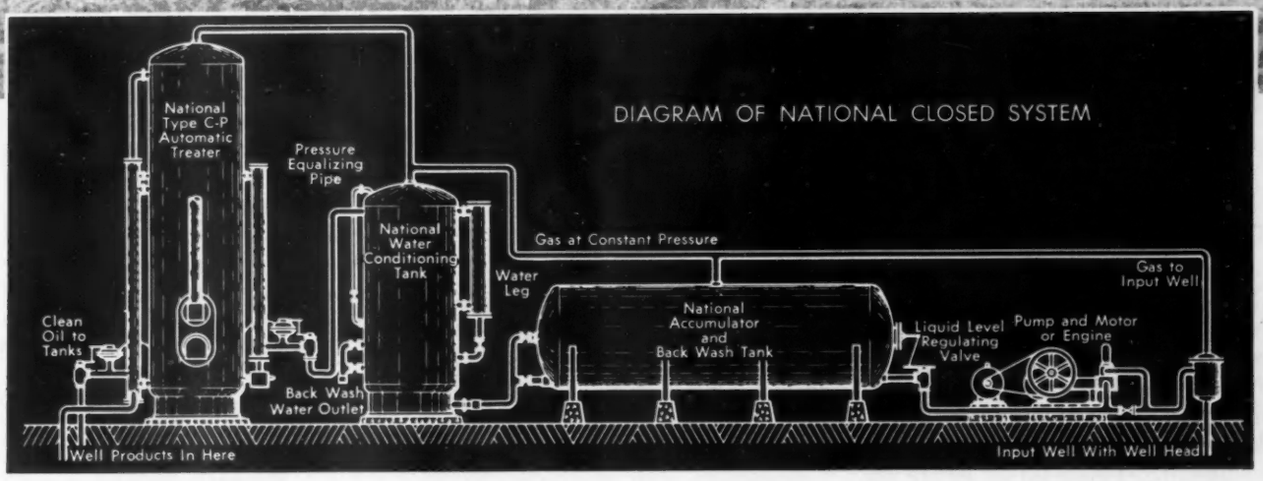
DIAGRAM OF NATIONAL CLOSED SYSTEM
National Type C-P Automatic Treater
Pressure Equalizing Pipe
National Water Conditioning Tank
Gas at Constant Pressure
Water Leg
Gas to Input Well
Clean Oil to Tanks
National Accumulator and Back Wash Tank
Liquid Level Regulating Valve
Pump and Motor or Engine
Back Wash Water Outlet
Well Products In Here
Input Well With Well Head

NATIONAL CLOSED WATER DISPOSAL SYSTEMS

... used for Pressure Maintenance

National Water Disposal Unit, Wesson Field, near Stephens, Arkansas.

2 10′ x 20′ horizontal accumulator and backwash
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On July 1, 1948, BHP had dropped to 412 PSI. Water injection began September 1, 1948.

To date, 36,758,358 bbls. of water have been returned to the formation and BOTTOM HOLE PRESSURE IS NOW 1357 PSI — 58 PSI GREATER THAN ORIGINAL PRESSURE.

Oil Production to date — 17,571,999 bbls.

Our Engineering Department welcomes inquiries concerning your water disposal problems.

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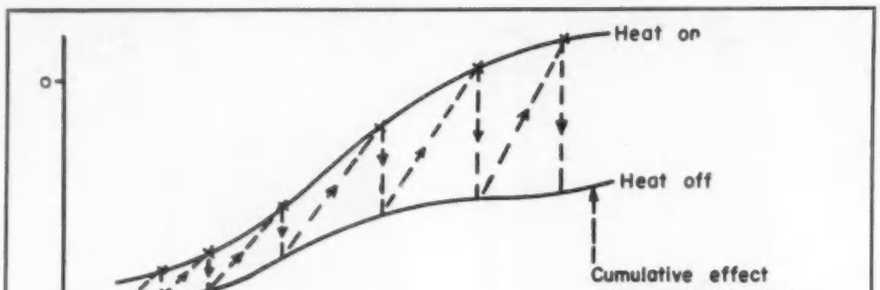


FIGURE 1—The gradual cumulative increase in permeability after successive heating and cooling of a core illustrates possibilities of the idea.

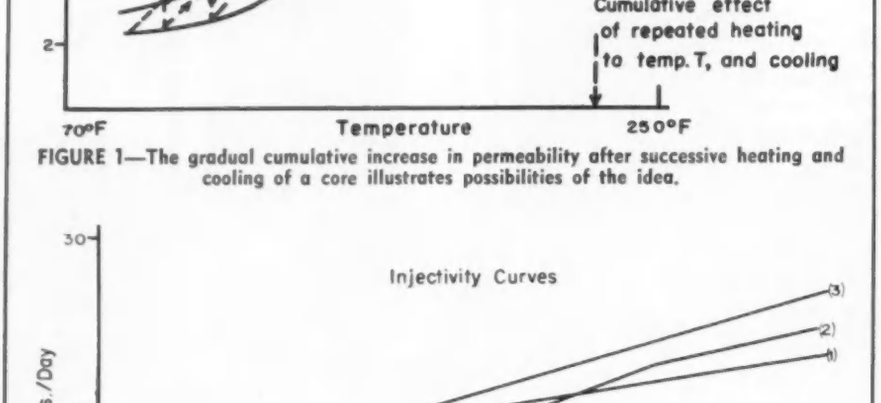


FIGURE 2—A cumulative increase in permeability is observed as a result of a month's heating even after a month's cooling.

to lower field residuals. This, of course, has definite limitations in the quantities of additional oil obtainable. The other approach is that of trying to find some new method, procedure, or chemical which will materially reduce the amount of residual oil left in the reservoir. This approach although a more difficult one would appear to offer the greater ultimate reward.

It is apparent too that both approaches are going to be involved in any really significant new developments. Some field experiments which have been conducted in the Bradford area with this general objective in mind will be described briefly.

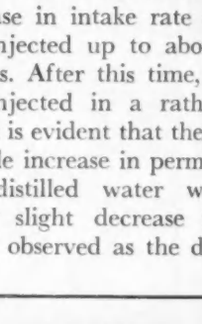
Heating of Injection Wells. The object of this procedure is to endeavor to inject more water without excessive pressures being used. Since the resistance to flow is concentrated around the well, if the permeability of this zone to water could be increased, then the rate of water injection could be increased without increasing the injection pressure. In the laboratory radial core samples were heated while water was flowed in at a constant pressure. It was observed that on heating, the rate of flow increased. Then when the core was cooled, the permeability did not decrease to the originally observed value. Rather, there was gradual cumulative increase in permeability after successive heating and cooling of the core. This effect is shown in Figure 1. In this experiment the core was repeatedly heated and allowed to cool. The upper curve traces the increase of throughput rates for successive heating periods to the temperatures indicated in the abscissa, while the lower curve shows the increased permeability after the core has cooled to room temperature following heating to the indicated temperature.

It was decided to carry this experiment immediately to the field without further lab study. For this an electrical heater was used. It was immersed in the well. The element was about 30 feet long enclosed in ¾-inch pipe. As in any good field test an attempt was made to control the other variables. One of the common faults in any field test is the fact that the data are not sufficiently stabilized prior to the test to tell whether the results obtained are due to the variable in which we are interested, or to something else that occurred during the experiment. A power input of about 35 kilowatts was used for one month. Temperatures ran up to about 250° F. The results are shown in Figure 2. It is observed that there is a cumulative increase in permeability as a result of a month's heating, even after the well has been allowed to cool off. In one case the final increase was about 20 percent, even after a period of over a year. In another well the increase was only about 10 percent. This suggests the possibility that it might be possible to go from well to well, heating each one for a month at a time and then continuing the flooding, getting higher input rates for the same injection pressure.

Effect of Wetting Agents. Two cores that had been previously cleaned in carbon tetrachloride were studied.

Figure 3 shows that there has been a gradual decrease in intake rate as the water was injected up to about 180 pore volumes. After this time, a detergent was injected in a rather dilute solution. It is evident that there was a considerable increase in permeability. When distilled water was added again, a slight decrease in permeability was observed as the de-

About the Author



H. G. BOTSET, head of the Petroleum Engineering department at the University of Pittsburgh, has held the position since 1946. After receiving a B.S. degree from Purdue University, he joined the staff of Standard Chemical Company as a physicist. He instructed in chemistry at Carnegie Institute of Technology and later became chief chemist for the Radium Dial Company. From 1930 to 1946 he was a research engineer with the Gulf Research & Development Company.

tergent was washed out of the core.

Figure 4 summarizes the results obtained in a field test using wetting agents. For several months prior to the injection of wetting agent, careful record was kept of the production. The injection pressure was maintained constant. Production for three months prior to the test is shown on the curve and indicates a regular slow decline. At the three month point, a 0.043 weight percent solution of detergent was introduced into the water for a few days. It was observed that there was an additional production of some 140 barrels of oil over an extended period and at the end of five months the production declined to what would be predicted if water had been used all the time. About four months later there was a second addition of a more dilute detergent solution which resulted in an increased production of 150 barrels over that predicted. There is, therefore, some evidence that wetting agents may be useful even if introduced after the water breakthrough point. The value of the additional oil obtained was about $760 while the wetting agent cost $275. The same effect was shown on another local lease in which an estimated additional 650 barrels of oil were produced due to detergent addition. One study of a 5-spot showed that there was considerable variation in the reservoir and that it was not homogeneous. When water was injected containing the detergent, very little of the detergent came through in two of the wells while in the third well there was considerable amount of the detergent coming through.

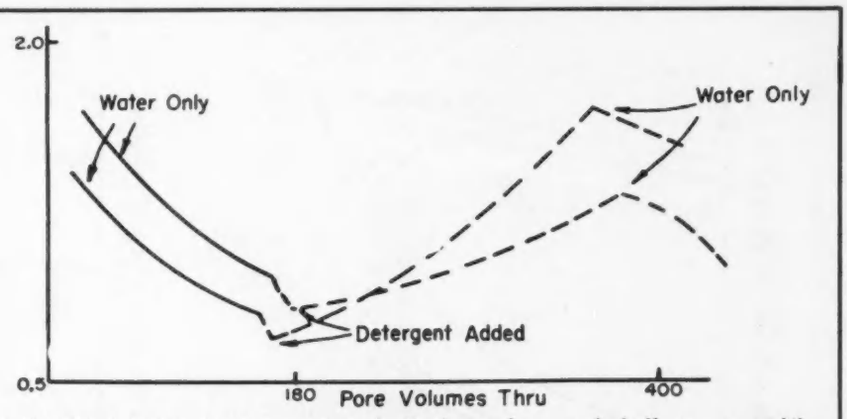


FIGURE 3—Injection of a detergent into the flood water has a marked effect on permeability of the core tested.

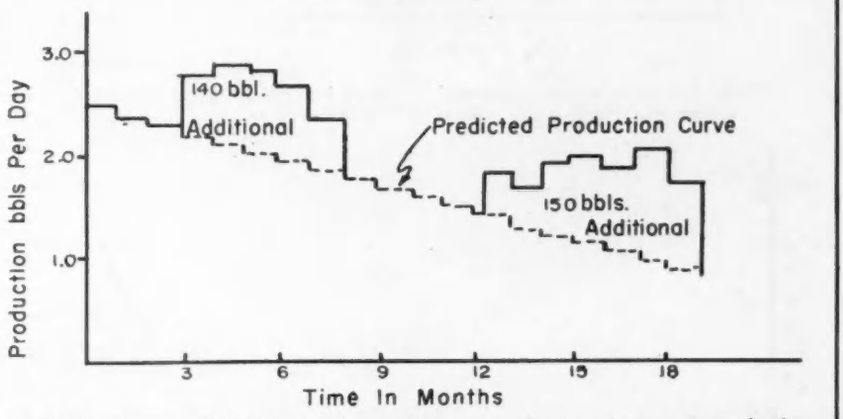


FIGURE 4—Summary of field tests using wetting agents shows an increase in production resulted.

Use of CO_2 in Secondary Recovery. There has been recently a great deal of interest in the possibility of using CO_2 to increase oil production in secondary recovery operations. It seems desirable, therefore, to discuss briefly the results of some laboratory experiments which have a bearing on this problem. One of the important effects of CO_2 on oil recovery is the fact that there is an increase in oil volume upon solution of CO_2 in the oil. Surprisingly to some, CO_2 is very soluble in crude oil and the pressure effect of solubility is even greater than might be observed with methane or ethane. The large increase in oil volume due to CO_2 solution might affect production. If the residual oil saturation can be reduced to say 25 percent and if the oil saturation at the beginning of the operation is 30 percent, then only one-sixth of the oil will be recovered. If CO_2 is injected and an increase in the volume to 50 percent of the pore space occurs, then if the oil plus CO_2 is reduced to 25 percent, one-half of the oil will be recovered.

Figure 5 gives an indication of the large increase in oil volume resulting from solution of CO_2 in crude. At approximately 800 psig the crude volume increases over 50 percent. Another method involving CO_2 is to use a carbonated water.

Figure 6 shows the volume percent increase in the crude oil as a result of being contacted under a given carbonation pressure with water containing varying amounts of CO_2 in solution. It was observed that there was about a 30 percent increase in the volume of the crude when a saturated CO_2-in-water solution was used. In long core flooding experiments the final oil saturation was reduced from about 25 percent to 10 percent of the pore space after CO_2 flooding.

Figure 7 shows the calculated effect of the increase in oil recovery in percent of pore volume as a result of the amount of CO_2 dissolved in the water.

The explanation of the increased recovery obtained in long core flooding tests in which CO_2-saturated water is used seems to be that the crude simply expands as the CO_2 dissolves in the oil. Since a larger fraction of the pore space is occupied by the expanded oil, a better movement of the oil is obtained during water flooding. In a long-core flooding experiment, a 5.5 percent CO_2-in-water solution by weight at 720 pounds per square inch carbonation pressure decreased the final oil saturation (pore volume percent) from about 33 percent to about 20 percent.

No free gas was produced because saturation pressure was maintained at the production end. The degree of expansion of the produced crude is in the neighborhood of 20 to 32 percent. One thing that should be noted here is that from about 75 pore volumes to perhaps 125 pore volumes of carbonated water were used in obtaining this reduction. This is much larger than normally would be used in the field.

In another experiment, water carbonated to 720 pounds per square

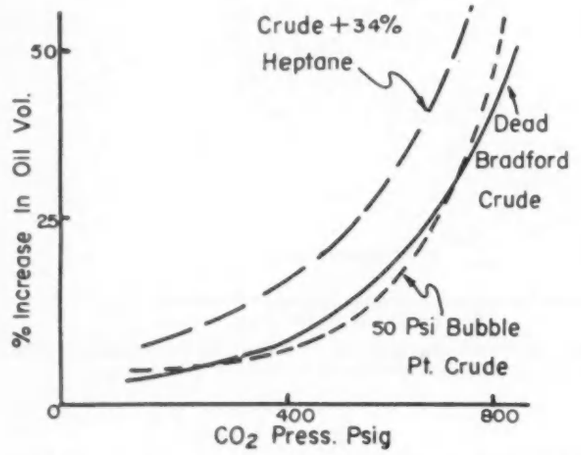


FIGURE 5—An indication is given of the large increase in oil volume resulting from the solution of CO_2 in the crude.

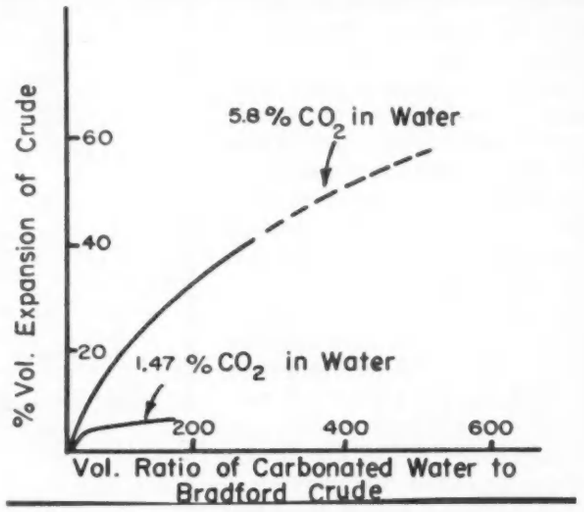


FIGURE 6—Carbonated water injected into the crude also caused an increase in oil volume.

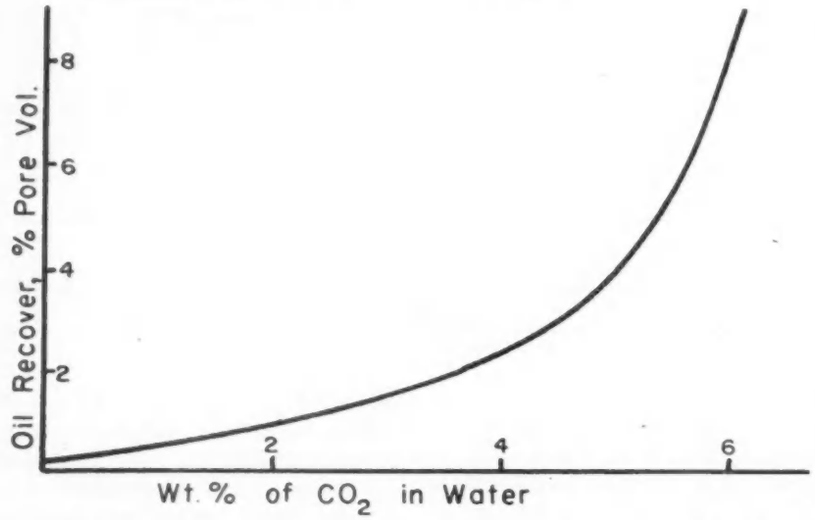


FIGURE 7—Calculated effect on oil recovery in percent of pore volume resulting from solution of CO_2 shows an increase.

inch lowered the oil saturation from 30 percent to 12 percent after 100 pore volumes had gone through. In contrast to this, a wetting agent in one experiment lowered the residual oil from about 14 to 13 percent of pore volume and another from 13 down to about 11 after the well had been flooded with carbonated water. The increase in pressure gradient caused no increase in oil recovery even if the outflow end of the core was at such a pressure that CO_2 came out of solution in the core.

It is also possible to flood a sand with pure liquid CO_2. In an experiment using liquid CO_2, the final oil saturation was reduced from 45 to 26 percent. About 20 pore volumes of CO_2 were forced through the sand. In another experiment using liquid CO_2 as the flooding medium, 2.5 pore volumes of liquid CO_2 reduced the oil saturation from 30 percent to about 10 percent.

In an additional experiment, a core was first flooded with carbonated water. This lowered the oil saturation from an initial 40 percent to about 26 percent with a throughput of 224 pore volumes of water. Subsequent flooding with liquid CO_2 reduced this saturation to 14 percent using only eight pore volumes of liquid CO_2. Liquid CO_2 in some cases may lower the residual to somewhere in the neighborhood of 10 percent of the pore volume in cores not previously flooded. In two examples, this occurred very rapidly in that the residual oil dropped from 30 percent to 10 percent while only two pore volumes of CO_2 were being forced through. These data may all be interpreted to show that the main effect is in the expanding of the crude volume due to the solution of CO_2 in the crude oil. In summary it is noticed that when carbonated water is used as the flooding medium, many pore volumes must be forced through the formation before significant results are obtained.

Effect of Gas Injection in Water-Flooding. Other work that has been done both in laboratory and field experiments is a study of the effect of injecting gas into the system ahead of and during flooding. It should not be expected that gas injected ahead of flooding—i.e., into the residual oil left after primary recovery—would have any appreciable effect on recovery. At the end of primary recovery, gas was presumably by-passing the oil. Therefore, it might be expected that the addition of a relatively small amount of additional free gas would have little effect on the oil distribution in the sand.

However, if water has been injected first, then the oil saturation distribution has been disturbed and gas injected later may serve to block the more permeable zones with gas so that the water is forced into the less permeable zones. This, of course, is desireable. Experiments of this type have been carried out in the laboratory using both insoluble and soluble gases.

In the field, injection of a few pore volumes of gas during water flooding is claimed to increase recovery. However, this may have been due to the effects of other variables since the ex-

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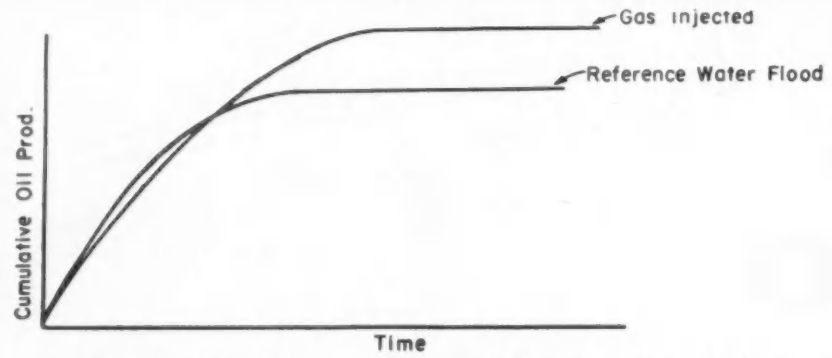

FIGURE 8—Injection of insoluble gas during a water-flood may have beneficial effects as indicated in this test.

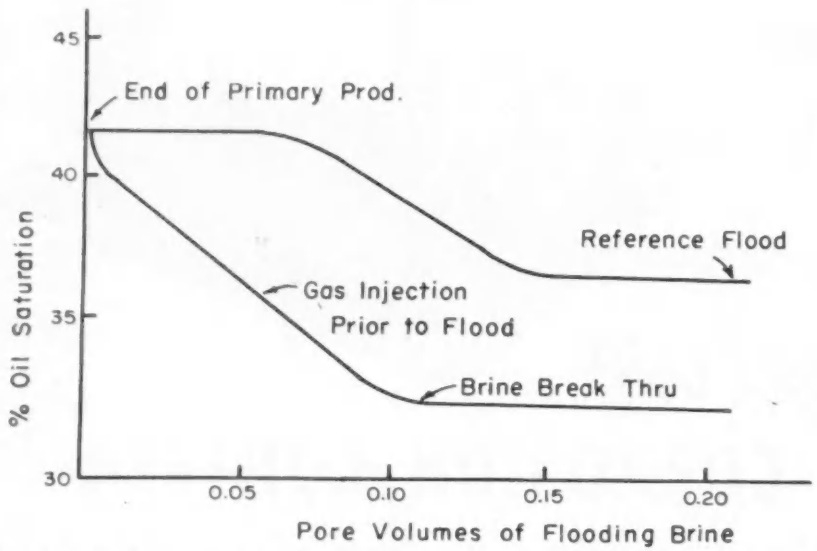

FIGURE 9—Here the same effect of lowered percentage oil saturation as a result of gas injection is shown.

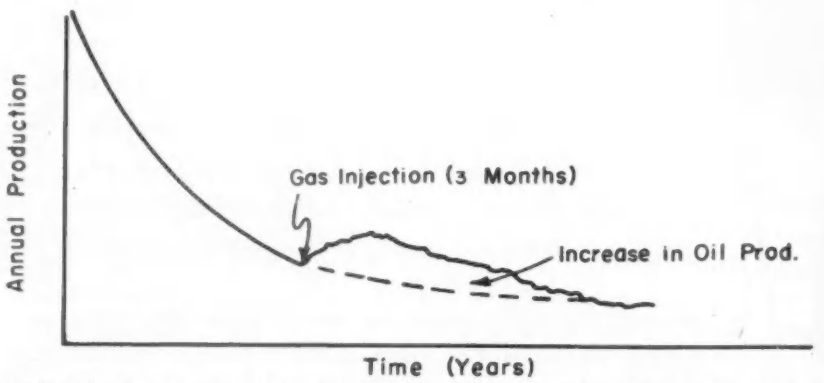

FIGURE 10—Increased oil production resulted in this field test simultaneously with injection of gas.

periments were not too carefully controlled.

The Pennsylvania Grade Crude Oil Association laboratory has conducted carefully controlled field tests. The wells had been flooded for a long time and good production data were available. Exhaust gas from a compressor was used, being carefully dehydrated before injection to prevent corrosion of injection lines. No corrosion of equipment was observed during the experiment. Corrosion test coupons were placed at various points in the system and gave negative results. The gas was essentially 80 percent nitrogen and 20 percent CO_2. The oil was being produced by flowing on the property on which this experiment was carried out. Approximately 300,000 cubic feet of exhaust gas were injected into each of four wells in a 5-spot in a period of about a month. The surface injection pressure was about 1300 psig. The results of this experiment were rather inconclusive although some indication of slightly increased recovery was obtained.

Laboratory experiments with long cores indicate that the injection of insoluble gas during a water-flood may have beneficial effects on oil recovery.

Figure 8 shows that in one such experiment there was a higher cumulative oil production eventually when gas was injected during the water flooding. (This well had already been water-flooded for a considerable length of time.)

Figure 9 shows the same effect of lowered percentage oil saturation as a result of gas injection.

One remarkable thing is the very low number of pore volumes of injected water that were required to produce the oil after gas injection. Figures 8 and 9 were for long laboratory cores.

Figure 10 shows the same effect for a field test though the effect is not too marked. The same result was observed in another field test. However, once again it must be specified that this may be due to changing other variables, during the course of the gas injection operation. Some operators in the Bradford area use this gas-injection method as a regular process. It is observed that an insoluble gas gives better results than a soluble gas such as propane. Thus, the major effect must be a mechanical one. However, it must be remembered that carbon dioxide is quite soluble in water.

This discussion has presented briefly a few of the attempts that are being made to use new techniques to increase the effectiveness of secondary recovery operations. The evaluation of any process or method in field application is extremely difficult because of the great variations that exist within and among various fields. Adequate control of operating conditions is almost impossible to achieve and, therefore, the evaluation of a new laboratory technique by field experimentation is fraught with many difficulties.

ACKNOWLEDGMENT

The author wishes to thank Dr. Charles F. Weinaug, chairman, Department of Petroleum Engineering, University of Kansas, Lawrence, Kansas, for his courtesy in permitting publication of this article, which is extracted from talks given at that institution.

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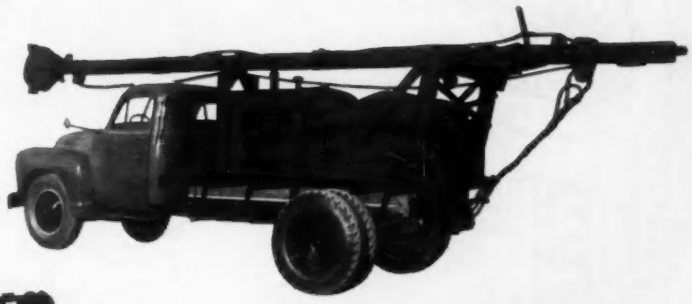

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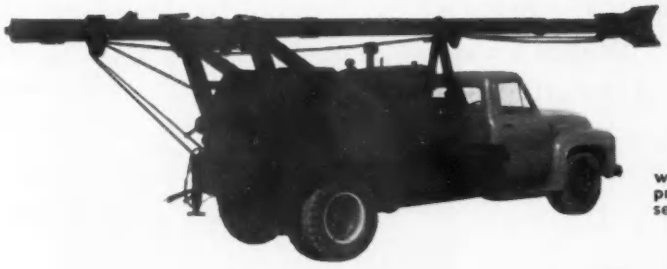

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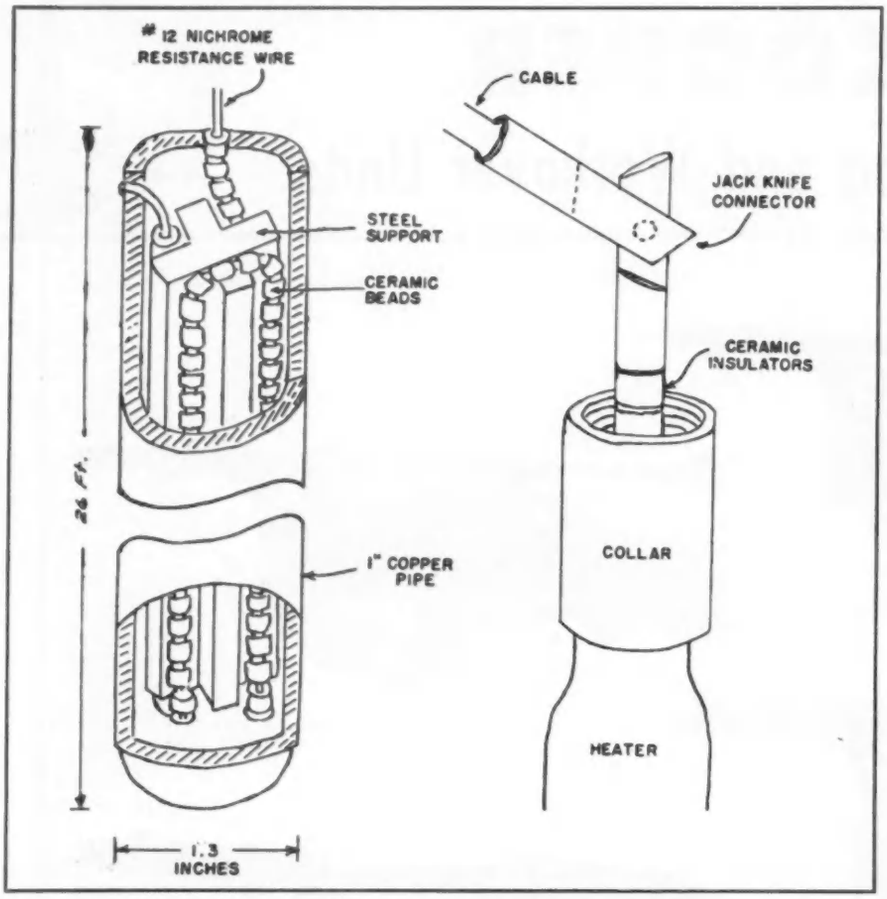

FIGURE 1—Construction of electric bottom hole heater and cable connectors.

Hot Water Injection Increases Water Input Rates

How feasible is a downhole electrical device for heating injection water? Here are . . . design . . . operation . . . economics . . . results . . . of a recent installation.

By J. N. BRESTON, Bradford Chemical Company
and B. R. PEARMAN, Sohio Petroleum Company

EXPERIMENTS CONDUCTED in the Bradfield field, Pennsylvania, with a down-hole heater resulted in an increase in water intake rate in three water-flood wells of 11 to 28 percent. Engineers who conducted the experiments pointed out that if such an increase in intake rate could be translated to a proportionate increase in production, it would be very significant from an economic standpoint.

The experiments showed that definite increases in water intake rates were effected by hot-water flooding although the effect did not take place until water temperatures of 140° to 170° F. were attained, and then continued to increase with each increase in temperature. The experiments were not carried above 250° F. due to limitations of the apparatus.

The heater apparatus used in the experiments was made of No. 12 nichrome resistance wire strung with ceramic beads and laced back and forth through the four quadrants of a steel cross support. The assembly was slipped into 1-inch copper pipe, and the voids filled with magnesia. One end of the resistance wire was welded to the copper pipe and the other end brought out of the top of the heater to a jackknife connector. The heater was 26 feet long and rated at 24 kilowatts when operating on 440 volts A. C. (Figure 1). Electricity was supplied to the heater by a one-wire insulated cable running down through the ¾-inch pipe, with the pipe serving as the return. The cable was cut to pipe joint lengths and fitted with jackknife connectors so it could be run with the pipe. Extreme caution was taken to insure against leakage at all threaded joints since little more than a drop of water was sufficient to short out the 400 volts. The hookup is shown in Figure 2.

The general testing procedure consisted of observing the well's equilibrium intake rate before installing the heater, after installation and after hot water injection. There were at least two periods of hot water injection for each well with sufficient time between to determine the cold water injection rate. The periods of hot water injection lasted from 3 to 10 weeks, or at least until the intake rate stopped climbing while the heat was still on. Several periods of hot water injection were experimented with to determine if successive treatments would continue to change the injection rate or whether one treatment alone would perform the ultimate.

In order to further analyze the effect of the treatments, pressure fall-off and injectivity tests were performed on the wells before and after treatment. In the case of one well temperature logs were run before treatment and again just after the heater was turned off and pulled out.

Upon termination of the heat treatments the intake rate behavior of the wells were charted for at least six months to determine how permanent the change in intake had been.

Test No. 1 was at the McManus W-18 drilled into the Bradford Third sand which is broken and where about half the sand has a permeability of 1 millidarcy or less, resulting in a low intake rate ever since the start of the

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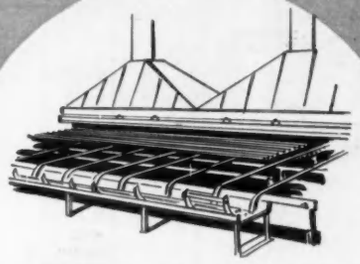

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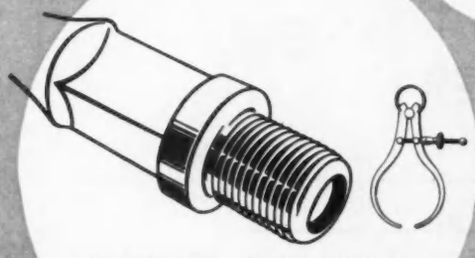

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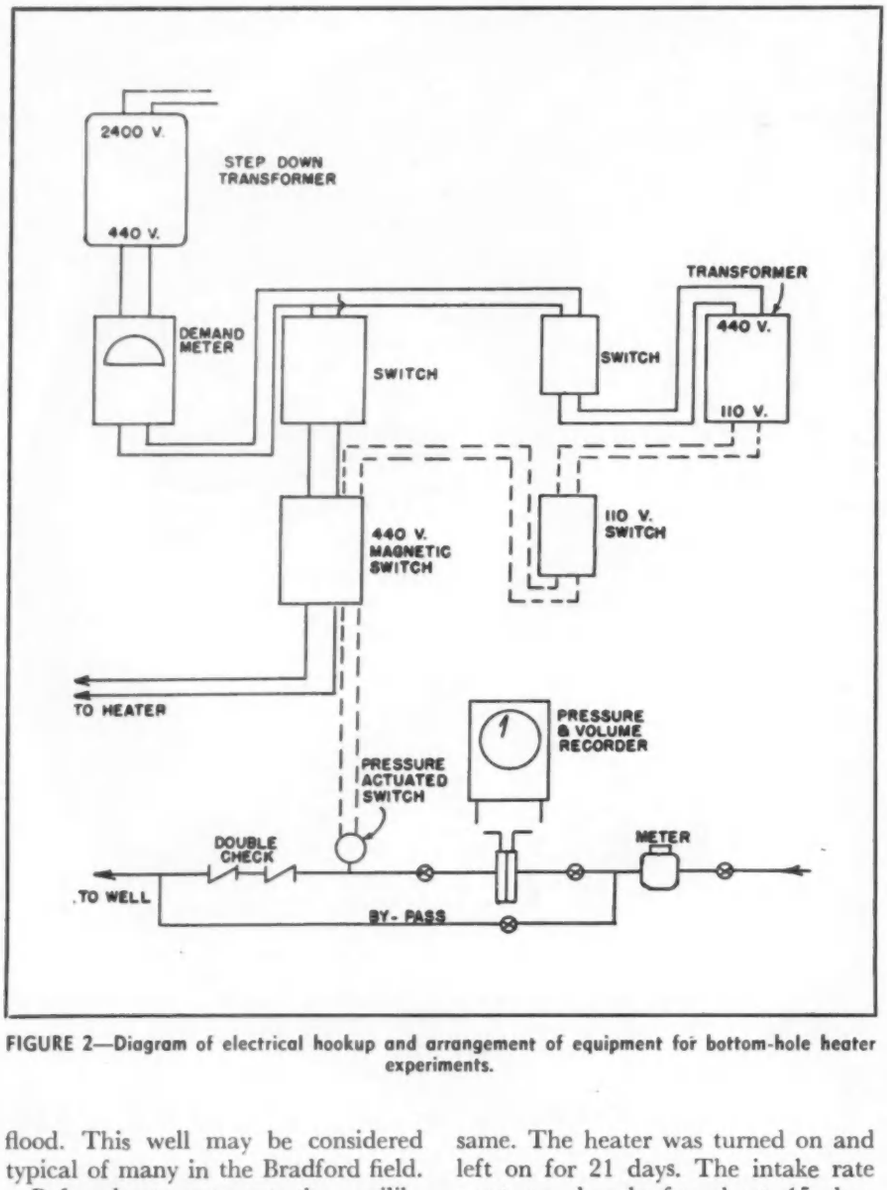


FIGURE 2—Diagram of electrical hookup and arrangement of equipment for bottom-hole heater experiments.

flood. This well may be considered typical of many in the Bradford field.

Before heat treatments the equilibrium intake rate of the well was determined as 16.8 barrels per day at an average well-head pressure of 1080 pounds per square inch gage. The heater was installed and after several weeks the intake rate was still the same. The heater was turned on and left on for 21 days. The intake rate went up sharply for about 15 days and then started to level off. After 21 days the intake rate stood at 21.1 bpd or an increase of 26 percent. The average bottom hole water temperature was calculated as 250° F.

The electricity was then turned off and after several days the intake rate started falling. Within 10 days it appeared to be leveling off at about 19 bpd. For the next month there was a series of disturbances on the lease causing erratic operation and low pressures. About the sixty-fifth day the plant was again functioning fairly smoothly although the pressure was still low. The heater was turned on again on the seventy-fifth day and the intake rate started to climb. After 20 days the intake rate appeared to be leveling off at 22.7 bpd for an increase of 35 percent over the original cold water injection rate of 16.8 bpd.

For the next 80 days the experiment was erratic and the heater was on only about half the time. On the one hundred seventy-eighth day the heater was shut off and the well allowed to cool. The intake rate came down slowly and then appeared to settle at about 21 bpd at a pressure of 1070 psig for a net increase in intake rate of 25 percent. One year later the intake rate was still 19 bpd or 13 percent higher than before hot water injection treatment. It may be surmised that a series of treatments may be the most effective way of boosting intake rate by hot water injection treatment. A complete intake rate and pressure history of this test is shown in Figure 3.

Test No. 2 was performed on the Booth DW-5, a well which was also drilled into the Bradford Third sand. The formation is broken into many sandy layers two-thirds of which had permeabilities of one millidarcy or less. The well is in an area where water bypassing between wells is fairly common although tests indicated there was no bypassing in this particular well.

The heater was installed in the well opposite the lower or less permeable

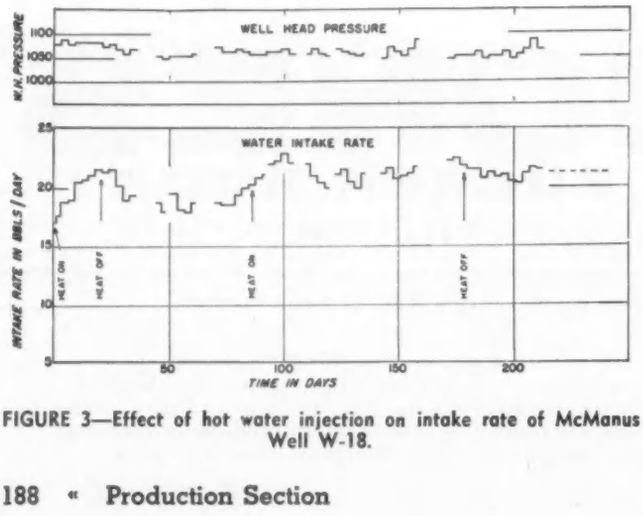


FIGURE 3—Effect of hot water injection on intake rate of McManus Well W-18.

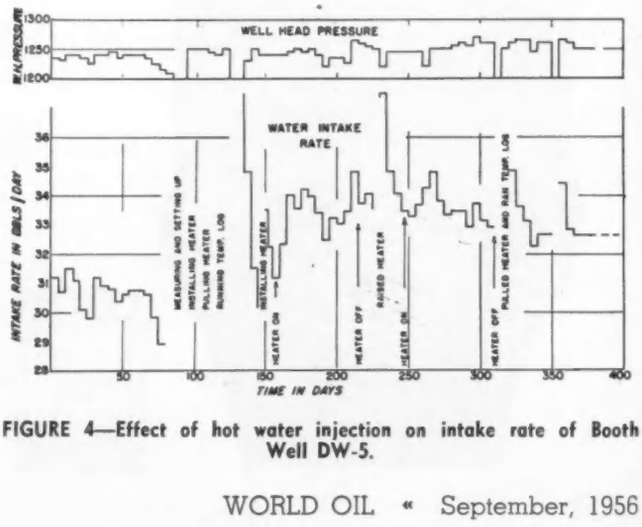


FIGURE 4—Effect of hot water injection on intake rate of Booth Well DW-5.

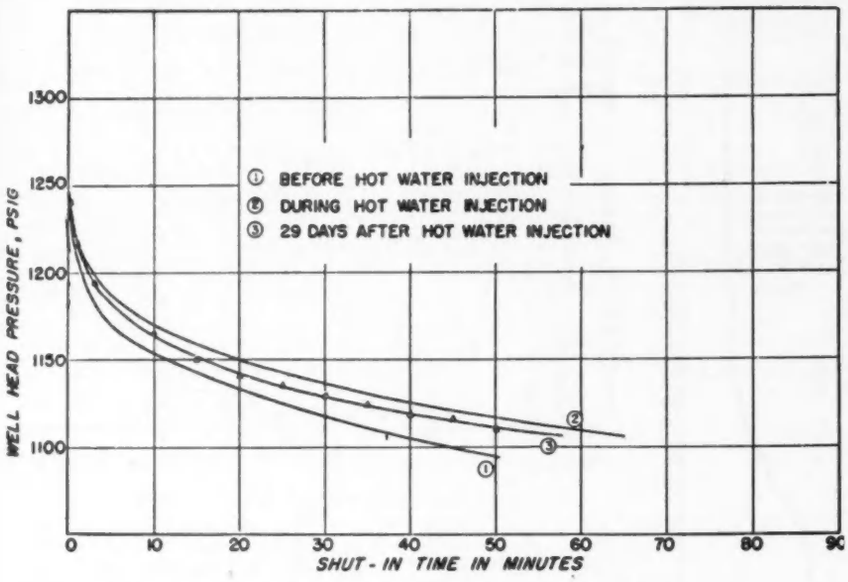


FIGURE 5—Pressure decline curves after shutting in Booth Well DW-5.

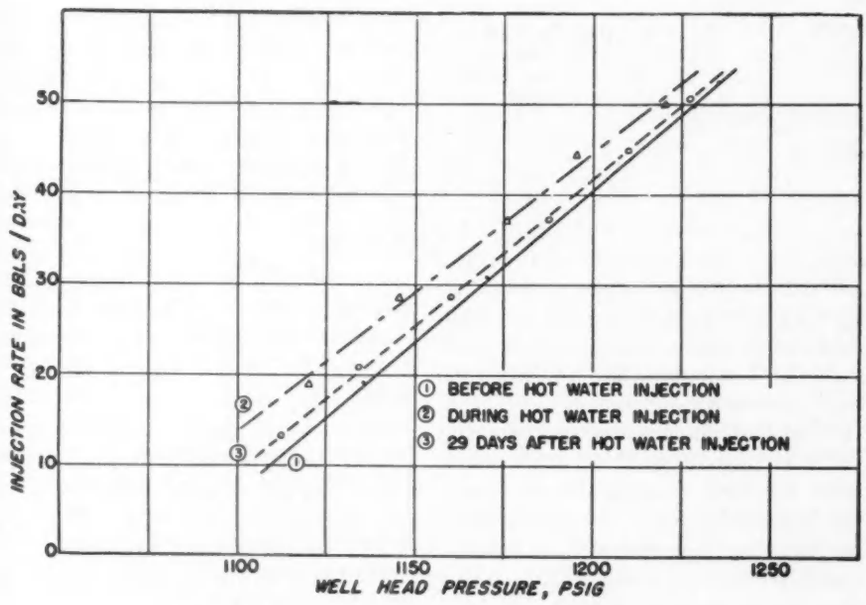
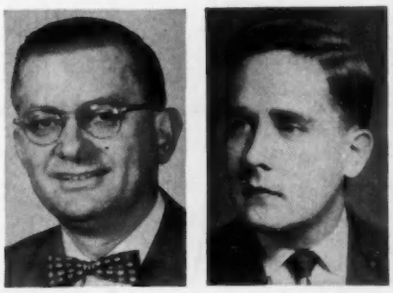


FIGURE 6—Water injectivity curves on Booth Well DW-5.

portion of the formation. Immediately after installation the heater short-circuited and while it was being repaired a temperature survey was run and the result indicated that most of the water was going into the upper part of the formation. A shut-in pressure decline curve and an injectivity rate curve were also determined for the well at the time it was at equilibrium.

The heater was installed again and the well allowed to come to equilibrium. After 10 days the intake rate was down to about 31 bpd and the heater was turned on. As shown in Figure 4 the intake rate rose to about 34 bpd and remained there for about 20 days. Then the intake rate dropped to about 33 bpd for about 20 days due to lower plant pressures. When plant pressure returned to normal the intake rate went up to about 34 bpd. After 57 days of hot water injection the heater was turned off. The intake rate dropped slightly over the next 10 days and would have dropped more had the plant pressure been down to normal. As soon as the heater was turned off measurements were made of the well's pressure decline rate when shut in, and the injectivity rates when turned back on. The values are

About the Authors



Breston Pearman

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BENJAMIN R. PEARMAN is employed by the Sohio Petroleum Company as an engineer in waterflood operations. After his graduation from the University of Pittsburgh with a B.S. degree in petroleum engineering in 1951, he joined the training program as a junior engineer of Stanolind Oil and Gas Company in West Texas. From 1952 to 1955 he was research field engineer with Pennsylvania Grade Crude Oil Association in Bradford, Penn.

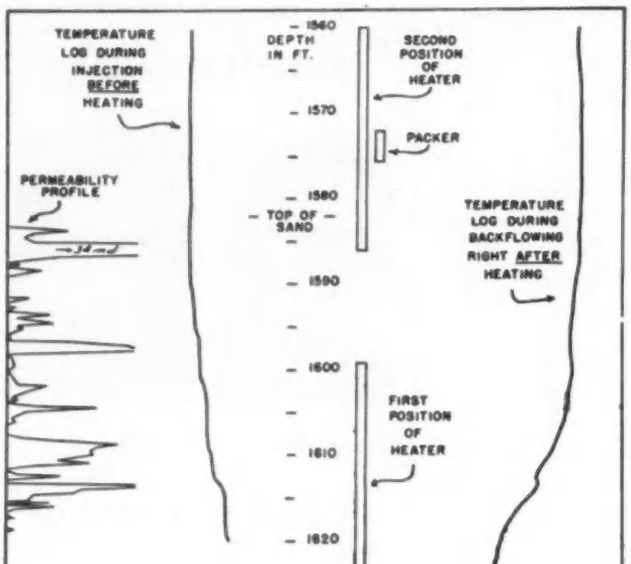

FIGURE 7—Permeability and temperature logs on Booth Well DW-5.

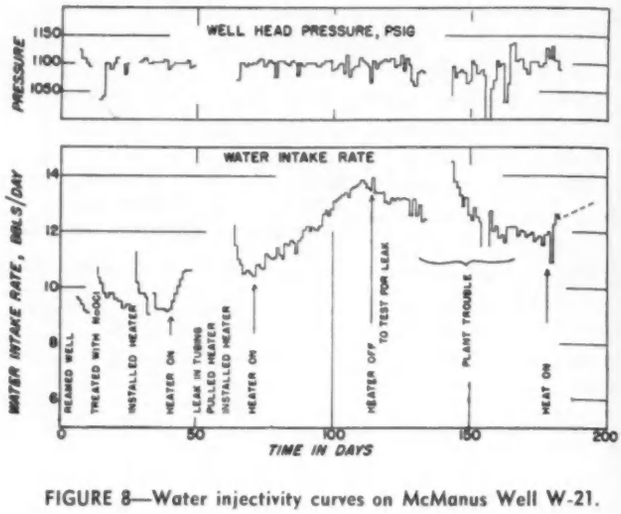

FIGURE 8—Water injectivity curves on McManus Well W-21.

plotted on Figures 5 and 6. When compared to the curves before heating they show little change.

The increase in intake rate of 3.5 bpd or about 11 percent appears rather small. However, since only about half of the total water was being heated, the increase in intake rate to the lower sands could have been greater than 11 percent. From the core log it can be estimated that about 55 percent of the injection water was going to the formation opposite and below the heater. Thus 16.7 bpd of the original 30.5 bpd were heated. Assuming the increased intake rate of 3.5 bpd is all attributable to the lower section, then the increase in intake could possibly be 21 percent. Continuing on the same assumptions, it was calculated that the temperature of the heated water at the sand face could have been as high as 350° F.

It was then decided to raise the heater, which had originally been bottomed at 1620 feet, so that 22 of its 26 feet length were above the top of the sand (see Figure 7). After the well had settled for 17 days and the intake rate appeared to be steady, the heater was turned on again. After five days the intake rate started rising, and it reached a maximum of 34.5 bpd after 20 days. Then it started to decline for some unknown reason and leveled off at approximately 33.2 bpd as shown in Figure 4.

After 67 days of hot water injection the heater was turned off and pulled from the well. During the six hours the heater was out of the well a temperature log was run on the formation while the well was backflowing. The log is plotted in Figure 7 and indicates that heated water had permeated and was backflowing from all of the permeable formation. As would be expected from the permeability profile, most of the heated water was injected into the more permeable upper formation from whence it backflowed at the highest temperature (110° F.). The calculated temperature of the heated injection water was 221° F. Since the backflow water was only 110° F. there is evidence to assume that there was a large heat loss to the formation and the temperature gradient away from the well bore was steep.

After taking the temperature log the water was turned back into the well. After fill-up the well settled down to 32.6 bpd where it remained for the next few months. The net increase in intake rate due to treatment may be estimated at 2.1 bpd or 6.5 percent which was disappointingly small.

About a month after the well was allowed to cool off, shut-in pressure decline rates and injectivity rates were measured again. These are plotted on Figures 5 and 6 along with those taken before hot water injection and those taken during hot water injection. The curves differ only slightly, which was to be expected since the increase in water intake rate was small.

Test No. 3 was in the McManus W-21, a well adjacent to and in the same five-spot as the McManus W-18 on which Test No. 1 was performed. It has the same broken sand character and showed low input rate right from the start of about 7.5 bpd.

In the other two tests hot water treatment was applied without cleaning the wells in any way. To determine whether a clean well would respond differently to hot water treatment the well in Test 3 was thoroughly cleaned before treatment. This raised the intake rate from 7.5 to 9.2 bpd. (Figure 8).

Then the heater was installed which disturbed the well again. However, after about a week the intake rate had again settled down to 9.2 bpd. The heater was turned on and within five days the intake rate rose to 10.6 bpd. A serious leak then developed at the adaptor on the well tubing which necessitated withdrawing the heater from the well for two weeks before

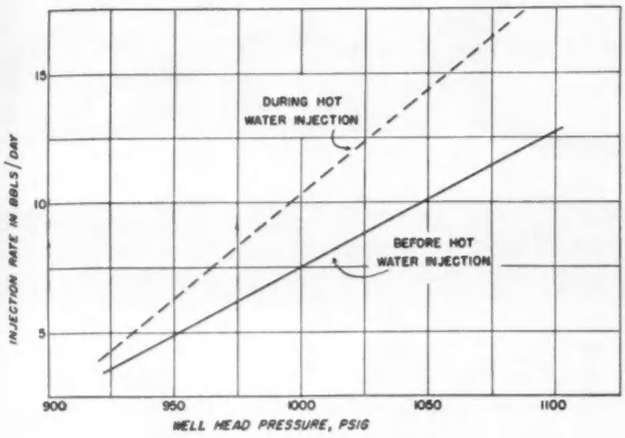

FIGURE 9—Increase in intake rate and temperature rise versus original intake rate.

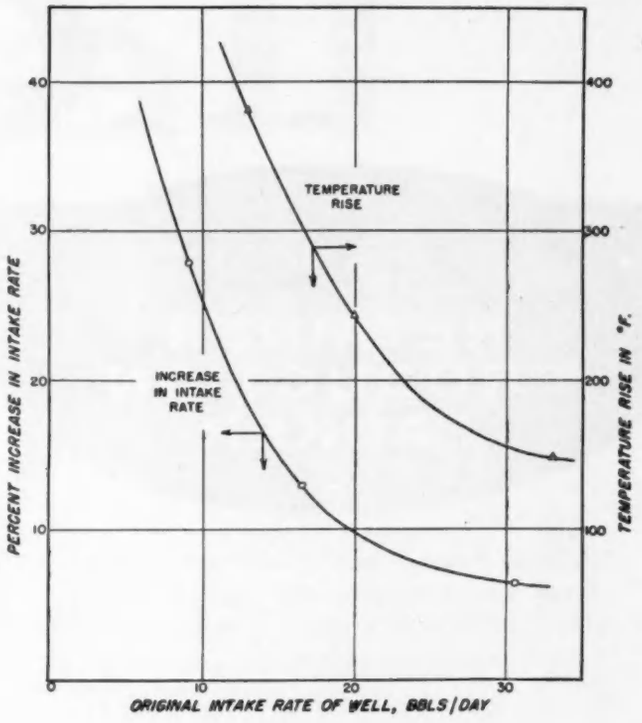

FIGURE 10—Effect of hot water injection on intake rate of McManus Well W-21.

the leak was repaired and the heater reinstalled. After another week the intake rate was down to 10.4 bpd and heater was turned on again.

The heater was on for 43 days during which time the intake rate rose steadily to about 13.7 bpd where it appeared to level off. Since the intake rate rose an unprecedented 50 percent and it was feared that there might be a leak down in the well, the heater was turned off. The intake rate then dropped slowly and appeared to be leveling off at 13.2 bpd. Unfortunately there was pump and engine trouble at the plant from then on for the next 40 days.

All the troubles were corrected about the one hundred seventieth day and by that time the well's intake rate had dropped to about 11.8 bpd. The heater was turned on again and the intake rate started rising. Just before this article was written the intake rate was back up to 13.8 bpd and still rising.

Assuming that the final equilibrium intake rate does not go any higher than 11.8 bpd the net increase in intake rate of this well can be estimated to be about 28 percent. This is higher than for the other two wells even though it had but one treatment to this point.

As in the case of the other tests, shut-in pressure fall-off rates and injectivity rates were determined on the well before and during treatment. Figure 9 shows the injectivity rates to be considerably higher during hot water injection than before. Due to erratic plant pressures it was impossible to obtain pressure fall-off and injectivity rates after the first hot water injection treatment.

On a basis of heater output and a water injection rate of 13 bpd it was calculated that the water in the well was as high as 440° F. On a basis of 9.2 bpd it could have been as high as 600° F.

Cost figures were not considered in these experiments but it was estimated that the electricity costs alone ran from $50 to $200.

It is interesting to note that the response of the wells were inversely proportional to the original intake rates and directly proportional to the temperature rise. This is graphically illustrated in Figure 10. If the Btu output of the heater was not limited, it would have been interesting to see what would have happened at temperatures above those reached in these tests.

It is also interesting to speculate on the mechanism or reasons for the increased intake rates after hot water injection treatment. The first suggestion that comes to mind is a removal of some of the residual oil with an attendant increase in relative permeability to water. Another possibility is the solution or modification of some of the unnatural plugging materials that may have found their way to the sand face and shot cracks during previous flooding. However, this would hardly be the reason for obtaining results in the laboratory where the flood water was clean and stable.

A more interesting possibility would be the solution or modification of some of the cementing materials in the sand. This has some credence when considered in the light of the results of some experiments[1] in which the permeability of limestones were increased considerably by heating them in water to moderate temperatures while under high pressure.

TABLE 1
Effect of Hot Water Treatment on Intake Rates of Bradford Sand Cores

Core No.	Approximate Air Perm. in Md.	Water Intake Before Treatment	Rate, Ml./Min. After Treatment	Percent Change in Intake Rate
97	2.0	0.44	1.30	+195
99	1.0	0.35	0.47	+ 34
101	0.5	0.0035	0.013	+270
102	0.5	0.19	0.21	+ 10
103	1.0	0.60	0.54	− 10
104	0.1	0.002	0.010	+400
105	1.5	0.45	0.51	+ 13
106	0.1	0.12	0.16	+ 33

REFERENCE

[1] "Expansion and Increase in Permeability of Carbonate Rocks." John C. Maxwell and Peter Verall, Trans. Am. Geophysical Union, Vol. 34, No. 1, February, 1953.

ACKNOWLEDGMENT

The authors wish to acknowledge the cooperation of the many people that made these experiments possible. In particular we wish to thank Quentin Wood, Kenneth Barton and Dr. E. T. Heck of the Minard Run Oil Company, Bradford, Pa.; Arthur Simmons and Stanley Grove of the Simmons Oil Company; Col. P. J. Stevenson and William Rindlaub of the Pennsylvania Electric Company; Roy McKnight of Woessner-McKnight, Inc.; James Bird of Bird Well Surveys. Other members of the Pennsylvania Grade Crude Oil Association Laboratory who helped in these experiments were Joseph Saxon, Jr., D. Thomas Byrne, Robert Neal and Willard Miller. We wish to thank the Production Research Technical Advisory Committee of the Pennsylvania Grade Crude Oil Association for their guidance and permission to publish the results of these experiments.

...One

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PRODUCT NO. 415-D

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Because it can also be used successfully as a squeeze tool, it is used in a variety of supplemental applications (such as testing, acidizing, formation fracturing, squeeze cementing, etc.) that might be required during the completion or work-over phase of a well. That is why the Baker Retainer Production Packer has been frequently referred to as the "universal" packer, because it is truly the *one* packer that can be used *for all* production and many supplemental applications.

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Can be run and set with the speed and accuracy of wire line, as well as on tubing or drill pipe.

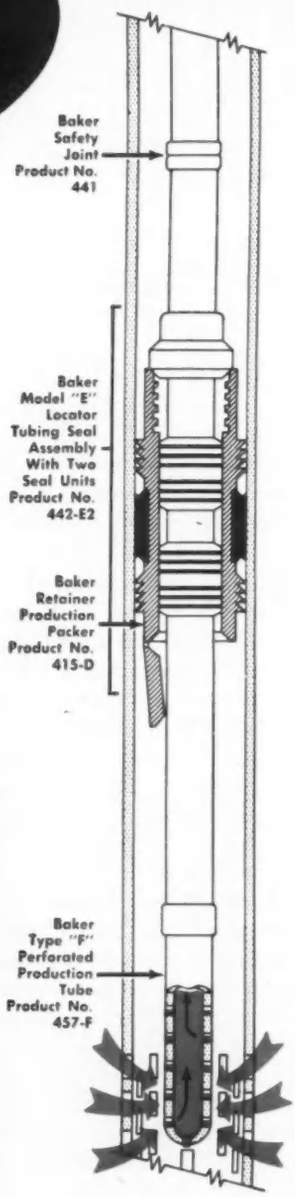
Holds any pressure from either above or below that is safe for the casing, even under temperatures in excess of 300°F.

Pack-off is independent of set-down weight or tension. Tubing string is free; just pick up (or unlatch and pick up) to remove it.

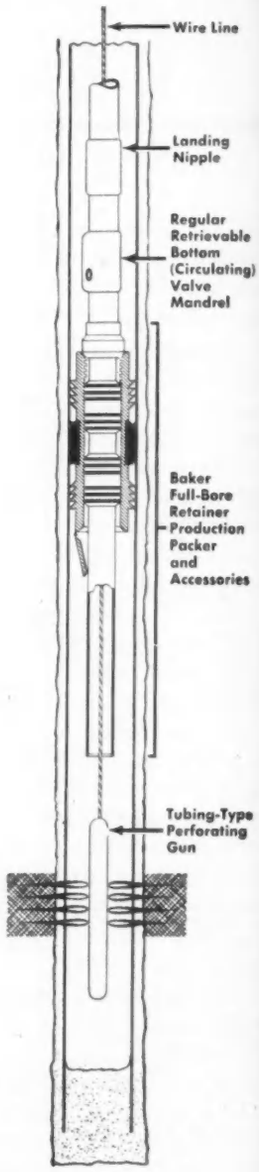
When tubing is removed, flapper valve closes to isolate zone below packer.

Baker Locator Tubing Seal Assembly Product No. 442-E2

Baker Retainer Production Packer Product No. 415-D


Baker Safety Joint Product No. 441
Baker Model "E" Locator Tubing Seal Assembly With Two Seal Units Product No. 442-E2
Baker Retainer Production Packer Product No. 415-D
Baker Type "F" Perforated Production Tube Product No. 457-F

Illustrates Packer set in casing with Locator Tubing Seal Assembly and Production Tube installed for single zone production.


Wire Line
Landing Nipple
Regular Retrievable Bottom (Circulating) Valve Mandrel
Baker Full-Bore Retainer Production Packer and Accessories
Tubing-Type Perforating Gun

Illustrates typical Permanent-Type Well Completion Hook-Up showing perforating operation through and below the Packer.

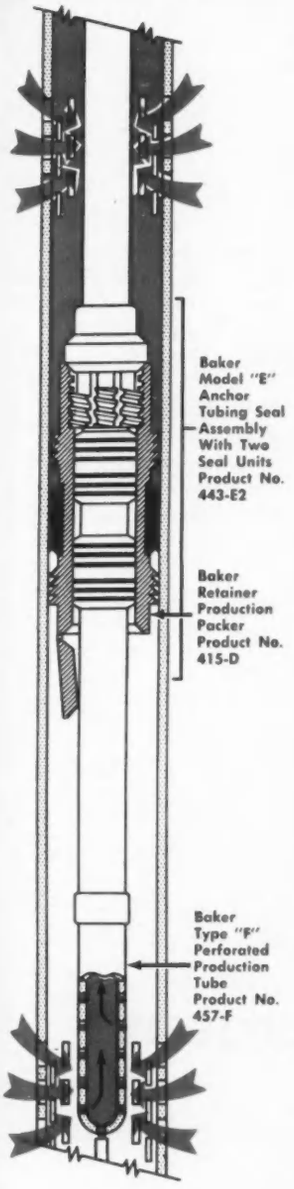
Successfully holds high pressures from above or below

. . . at shallow or record depths
even under temperatures in excess of 300°F.

for all

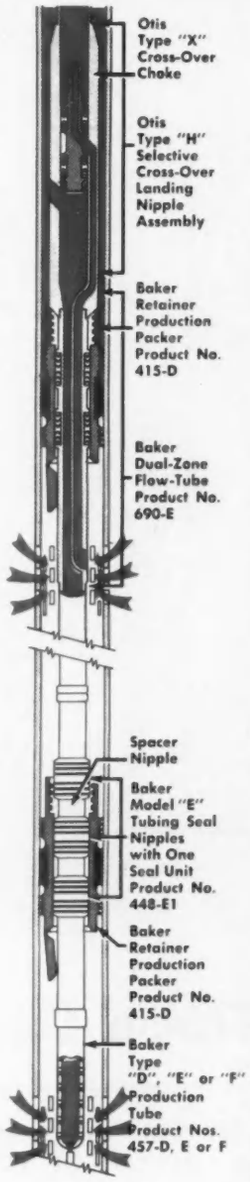
DUAL ZONE

SINGLE PACKER


Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Baker Retainer Production Packer Product No. 415-D
Baker Type "F" Perforated Production Tube Product No. 457-F

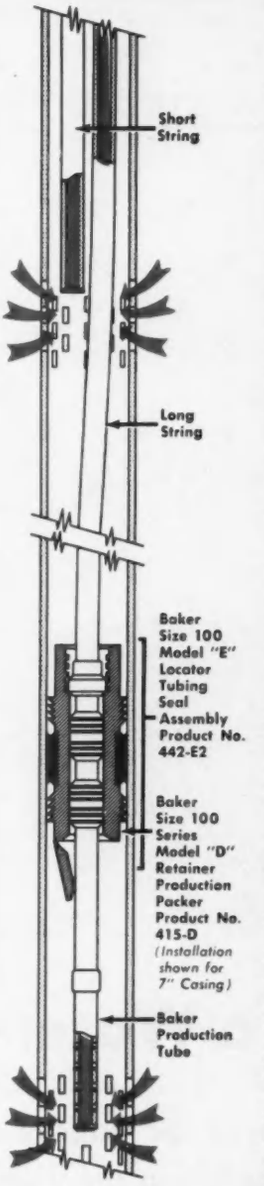
Illustrates Packer set in casing, with anchored production string for dual zone production. Tubing can be released from packer by rotating to right.

SELECTIVE CROSS-OVER


Otis Type "X" Cross-Over Choke
Otis Type "H" Selective Cross-Over Landing Nipple Assembly
Baker Retainer Production Packer Product No. 415-D
Baker Dual-Zone Flow-Tube Product No. 690-E
Spacer Nipple
Baker Model "E" Tubing Seal Nipples with One Seal Unit Product No. 448-E1
Baker Retainer Production Packer Product No. 415-D
Baker Type "D", "E" or "F" Production Tube Product Nos. 457-D, E or F

Illustrates selective two packer dual zone production hook-up (Baker-Otis) with Cross-over Choke installed. Flow pattern can be switched with Parallel Flow Choke.

PARALLEL STRING


Short String
Long String
Baker Size 100 Model "E" Locator Tubing Seal Assembly Product No. 442-E2
Baker Size 100 Series Model "D" Retainer Production Packer Product No. 415-D (Installation shown for 7" Casing)
Baker Production Tube

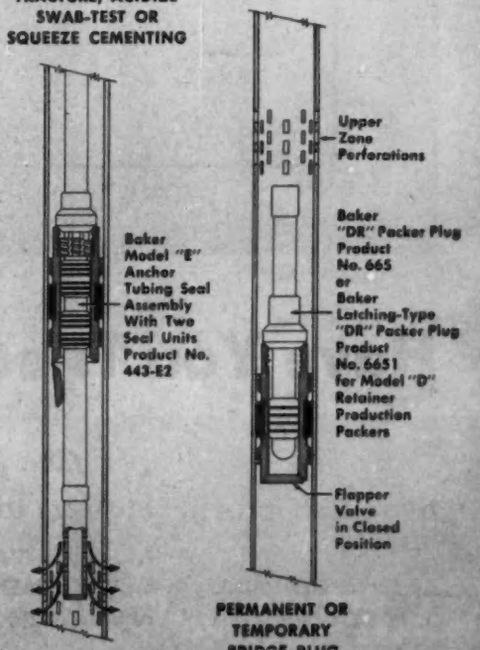
Illustrates simplest type of parallel string installation. Other installations involving two packers with full-opening tubing running through and below lower packer available.

SUPPLEMENTAL APPLICATIONS

WATER OR GAS INJECTION

The Baker Retainer Production Packer contains features that permit it to be used as a squeeze or testing tool as well as a temporary or permanent bridge plug. It is thus used in a variety of supplemental applications such as gas or water injection, testing, fracturing, acidizing, etc., that may be required either during the completion phase of a well or during a later phase.

FRACTURE, ACIDIZE SWAB-TEST OR SQUEEZE CEMENTING


Baker Model "E" Anchor Tubing Seal Assembly With Two Seal Units Product No. 443-E2
Upper Zone Perforations
Baker "DR" Packer Plug Product No. 665 or Baker Latching-Type "DR" Packer Plug Product No. 6651 for Model "D" Retainer Production Packers
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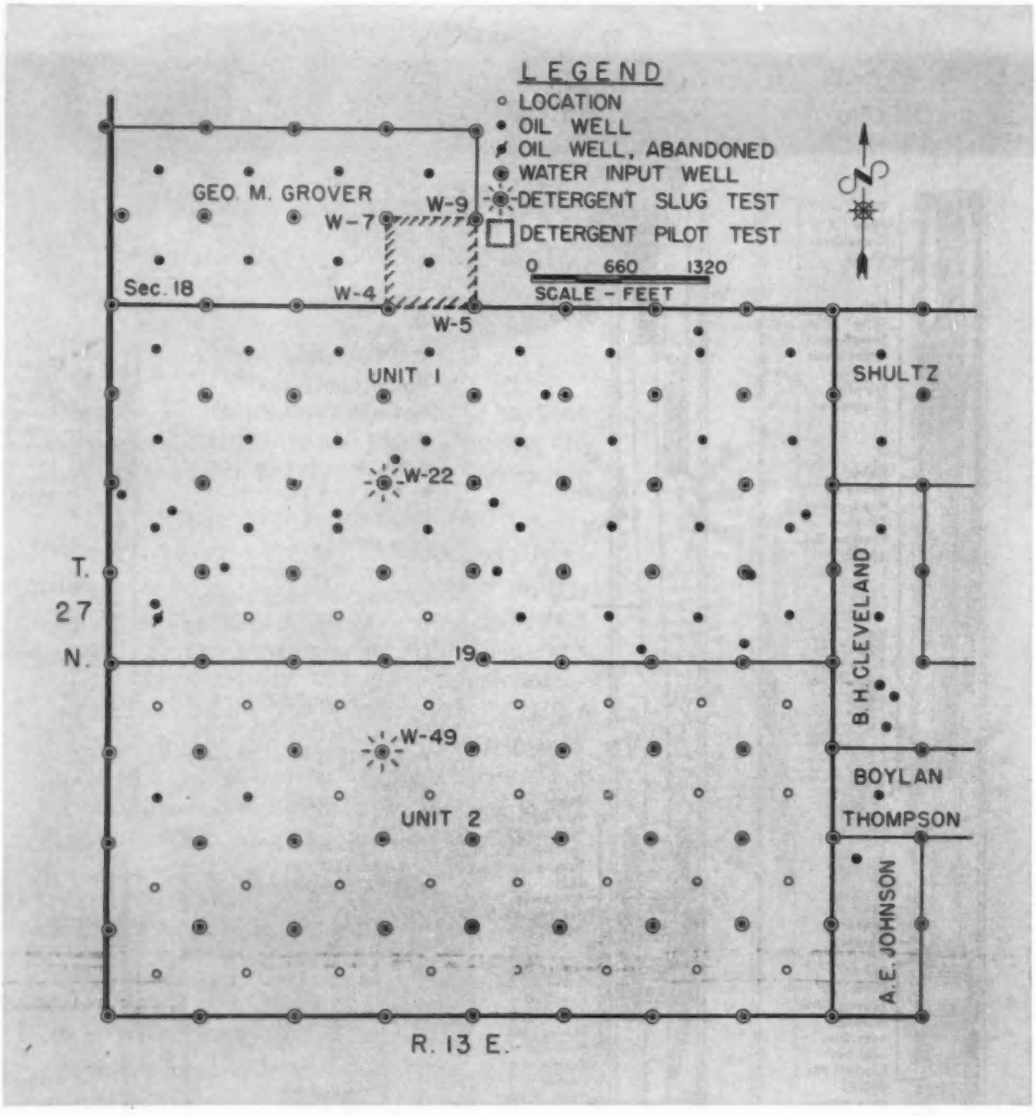


FIGURE 1—Hoyt Oil Company Grover flood in Washington County, Oklahoma, was the scene of these detergent tests. Wells marked with radial dashes received the slug treatment. A pilot list of continuous detergent injection was made in the four input wells of the 5-spot pattern in the hachured area.

Have You Tried a Water-Flood Detergent?

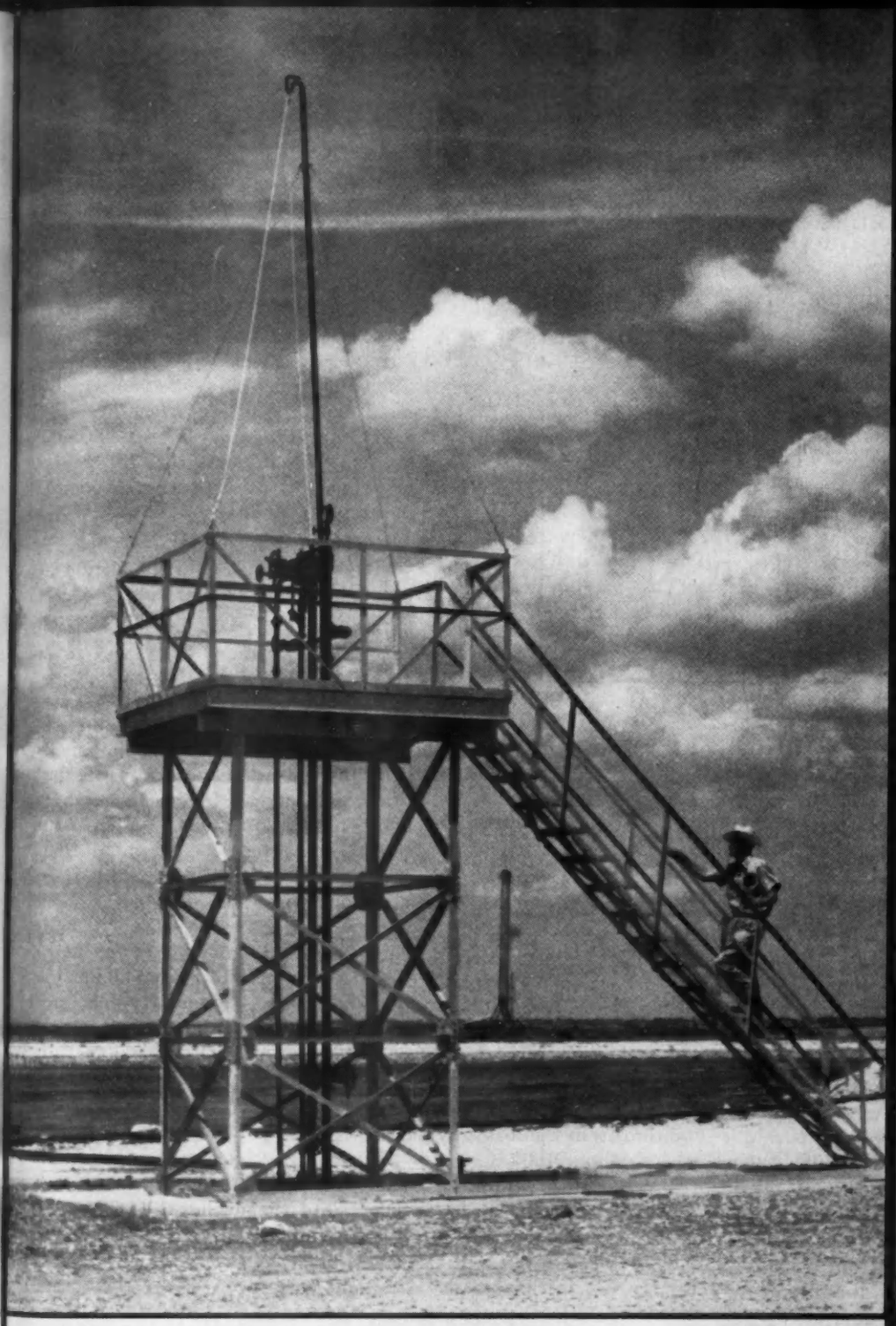
Field tests have proven the value of detergents in water-flooding. Results of these tests provide answers to important questions.

By H. N. DUNNING, R. T. JOHANSEN, C. J. WALKER, J. P. POWELL, and H. W. WATKINS

Petroleum Experiment Station, Bureau of Mines
U. S. Department of the Interior, Bartlesville, Okla.

USE OF DETERGENTS as flood-water additives is a secondary-recovery technique that has received intensive study. Laboratory tests show conclusively that dilute solutions of carefully selected detergents remove considerably more oil from unconsolidated sand than does water.[1, 2, 3, 4, 10] Use of water soluble detergents results in a reduction of residual oil in small radial cores; other substances are generally ineffective.[5, 6, 7]

Results of only a few field tests with detergents as flood-water additives have been published.[8, 9] The early tests



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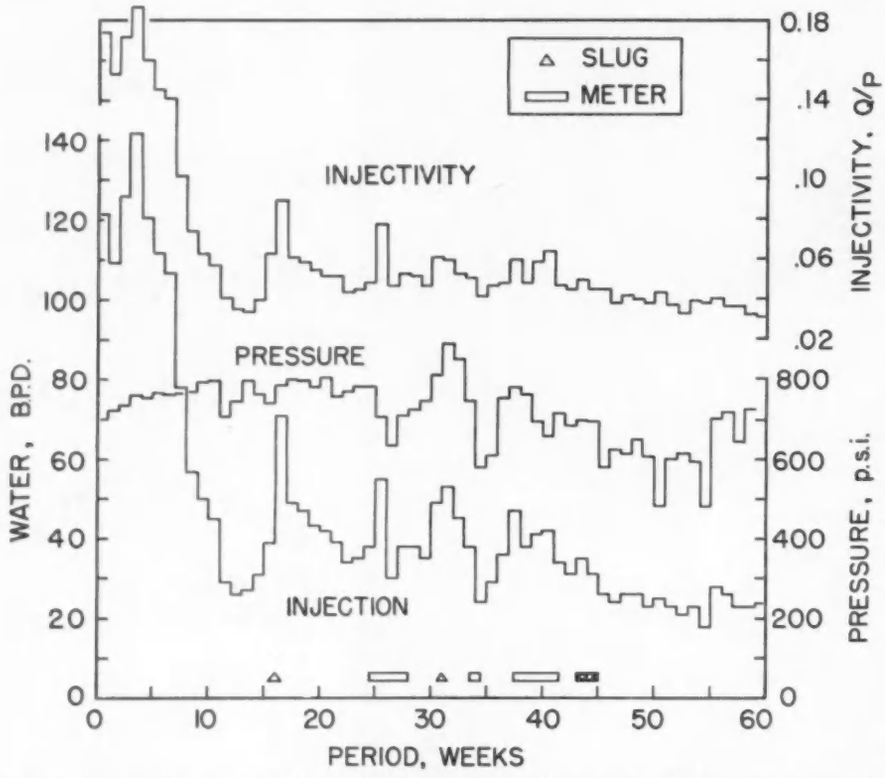

FIGURE 2—Injection record of Well HW-49 (1954 and 1955) indicated that the treatment with detergent achieved both local and general improvement in formation permeability.

were concerned primarily with oil recovery. Although oil recovery remains the controlling economic factor, there is good reason to believe that selective increases in water-injection rates may result in ultimate increases in oil production. Some laboratory studies and field tests have shown an increased injection rate as a result of using detergents as flood-water additives.[9,10]

Water-soluble non-ionic detergents consistently have been among the most effective detergents tested. A field test was arranged for a water-soluble non-ionic detergent with high interfacial activity and good hydrophilic-lipophilic balance which had proved successful in the laboratory. The test period began January 1, 1954, and ended March 1, 1955. Periods of time are indicated by weeks from January 1, 1954.

Drilling and Production History. Water-flooding was begun on Hoyt Oil Company Grover flood in secs. 18, 19, and 20, T. 27 N., R. 13 E., Washington County, Oklahoma, in January, 1950. Figure 1 is a map showing the status of the project to November 1, 1954. Input wells located on the north property line were drilled and completed first. The flood was expanded to cover the Grover 80 acres in 1952 and expanded further to include Unit 1 in 1953. The plant was enlarged and additional wells were drilled in sec. 19 and parts of sec. 20 during 1954.

The formation flooded is the Bartlesville sand, which occurs at a depth of about 1300 feet in the Cherokee shale group of Pennsylvanian age. Within the flooded area there is an average thickness of 22 feet of oil sand. The operator estimates that approximately 2000 barrels of oil per acre was produced from the leases by primary methods. About 1500 barrels of oil per acre was produced from the Grover lease by water-flooding during the first five years of operation.

Approximately 7500 barrels of the 8300 barrels of water injected daily during the detergent tests was pumped from the Caney river which flows through the property. The remaining 800 barrels of water was brine produced from the Bartlesville sand and separated from the crude oil in gunbarrels. Potential corrosivity and plugging characteristics of the treated water were low. Before injection the water was treated with lime, alum and high-test hypochlorite. After treatment the water flowed through two sedimentation ponds and was filtered.

Detergent Injection. The simplest method for treating a single well with detergent appears to be the slug treatment in which several gallons of detergent is injected into a well within a few minutes. The field test was initiated by selecting two wells, Hoyt W-22 and Hoyt W-49, for treatment by injection of slugs of detergent. These wells are indicated on the property map (Figure 1) by radial dashes.

A ten-gallon slug of detergent was introduced into HW-22 during the sixteenth week. This detergent treatment had little effect on the average injection rate, which increased only slightly for four weeks after the treatment, with a corresponding increase in pressure.

Rates of production of two old oil wells close to well HW-22 were recorded and samples were obtained at intervals during and after the tests. No detergent had been detected in either the water or oil from these wells to June, 1955.

Rate of oil production from one of the two old adjacent wells remained constant; oil-production rate of the other well increased from an average of about 5 bpd (during the first 16 weeks of the year) to 9 bpd during the eighteenth week. After this, the oil-production rate increased slowly and remained at about 13 bpd throughout the remainder of the year. Water production rose from about 0.5 bpd during the eighteenth week and averaged 5 bpd throughout the rest of the year. Whether or not this marked increase in production was caused by the detergent slug treatment is not certain.

During the sixteenth week a ten-gallon slug of detergent also was injected into the wellhead of HW-49, followed by 35 gallons of water, after which the well was shut-in for a 24-hour period. Injection then was continued at full field pressure.

The slug treatment resulted in a large increase in the rate of injection. Injection then decreased steadily until it was back to the original level after seven weeks.

Effects of this and subsequent detergent treatments are shown in Figure 2 in which injection rates, pressures and injectivity values during 1954 are plotted. On this and following figures, slug treatments are indicated by triangles and subsequent continuous additions of low concentrations of detergent to the water are designated by horizontal bars. The

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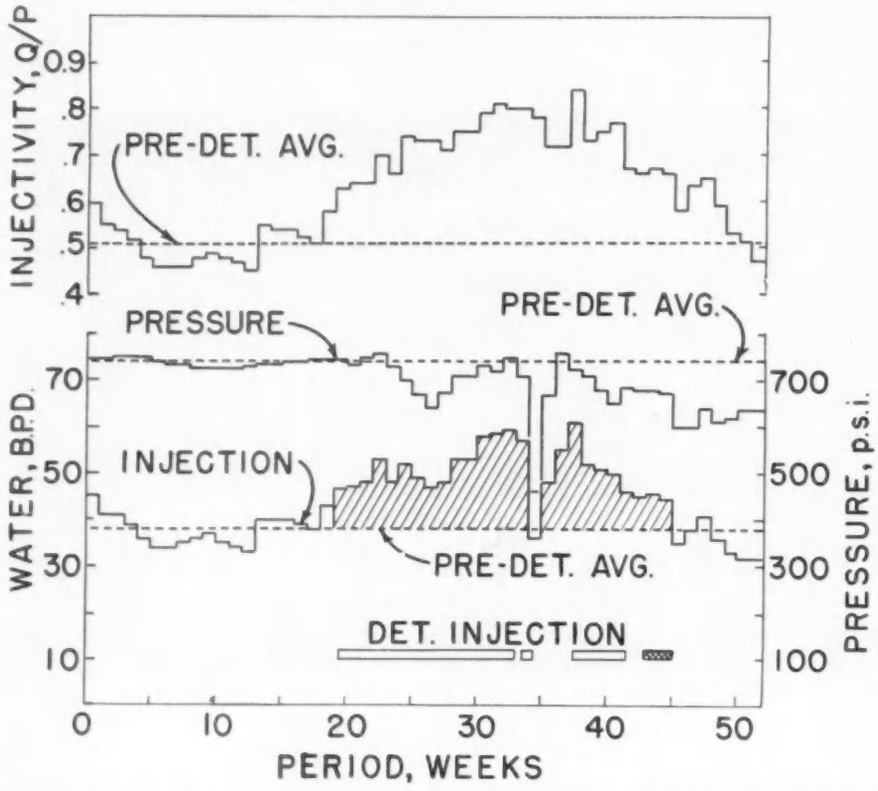


FIGURE 3—Here is average injection record of the three tight wells (GW-7, HW-4, HW-5) in the 5-spot pattern. A 10 percent increase was obtained for Well GW-9. Average injectivity increase was 19 percent, indicating that tight wells benefitted most from detergent injection.

horizontal, cross-hatched bars denote simultaneous injection of two detergents, described later.

The term "injectivity" denotes the value of Q/P when Q = injection rate (barrels per day) and P = wellhead pressure (psig). This is differentiated from "injectivity index" which will be used to designate the localized injectivity index described by Dickey and Andresen.[11]

To test the effect of smaller, more frequent detergent injections, one-third gallon of 10 percent detergent solution was introduced at the wellhead daily during the twenty-fourth through twenty-seventh weeks. This injection was made at full line pressure each morning with a hand pump and required about five minutes. Enough detergent was injected during this period to average 20 parts per million in the water injected.

Another slug treatment of the well was made during the thirty-first week. The well was shut-in for only a half-hour period during this treatment and the detergent was introduced at full line pressure.

Results of the discontinuous metering of detergent into HW-49 are masked by a sharp decrease in pressure that occurred shortly after the test began. This also is true of the second slug treatment, except that a small increase in injectivity was noted immediately following the slug treatment.

Pressure-decline-rate tests[12] were made before and after the first slug of detergent was injected. Calculations from results of these tests indicate an increase in permeability of the zone immediately around the well bore exceeding an increase in effective permeability of the formation some distance from the well. Therefore, the treatment with detergent achieved both local and general improvements in formation permeability.

The four input wells of a 5-spot pattern in the Grover flood were selected for a pilot test of continuous detergent injection. The wells included in the test were Grover W-7, Grover W-9, Hoyt W-4 and Hoyt W-5, indicated on the property map (Figure 1) by the hatched area. Detergent was injected into a common line supplying water to these four wells by a chemical proportioning pump so that the injection water contained 60 ppm for five weeks, 50 ppm for four weeks, and 45 ppm for another four consecutive weeks, beginning with the twentieth week.

The average daily rate of total injection for wells GW-7, HW-4 and HW-5 during 1954 is shown in Figure 3. Records for the four wells in the 5-spot pattern into which detergent was metered for 13 weeks are subdivided in this manner because the first three were tight (low injectivity) wells, while GW-9 was a loose (high injectivity) well into which the rate of water entry was controlled.

As indicated in Figure 3 by the hatched area, injection of dilute detergent solutions into these wells for an extended period resulted in a 34 percent increase in injection although average pressure during the addition of detergent to the water injected was lower than that preceding the test. The effect appears to have been a temporary one.

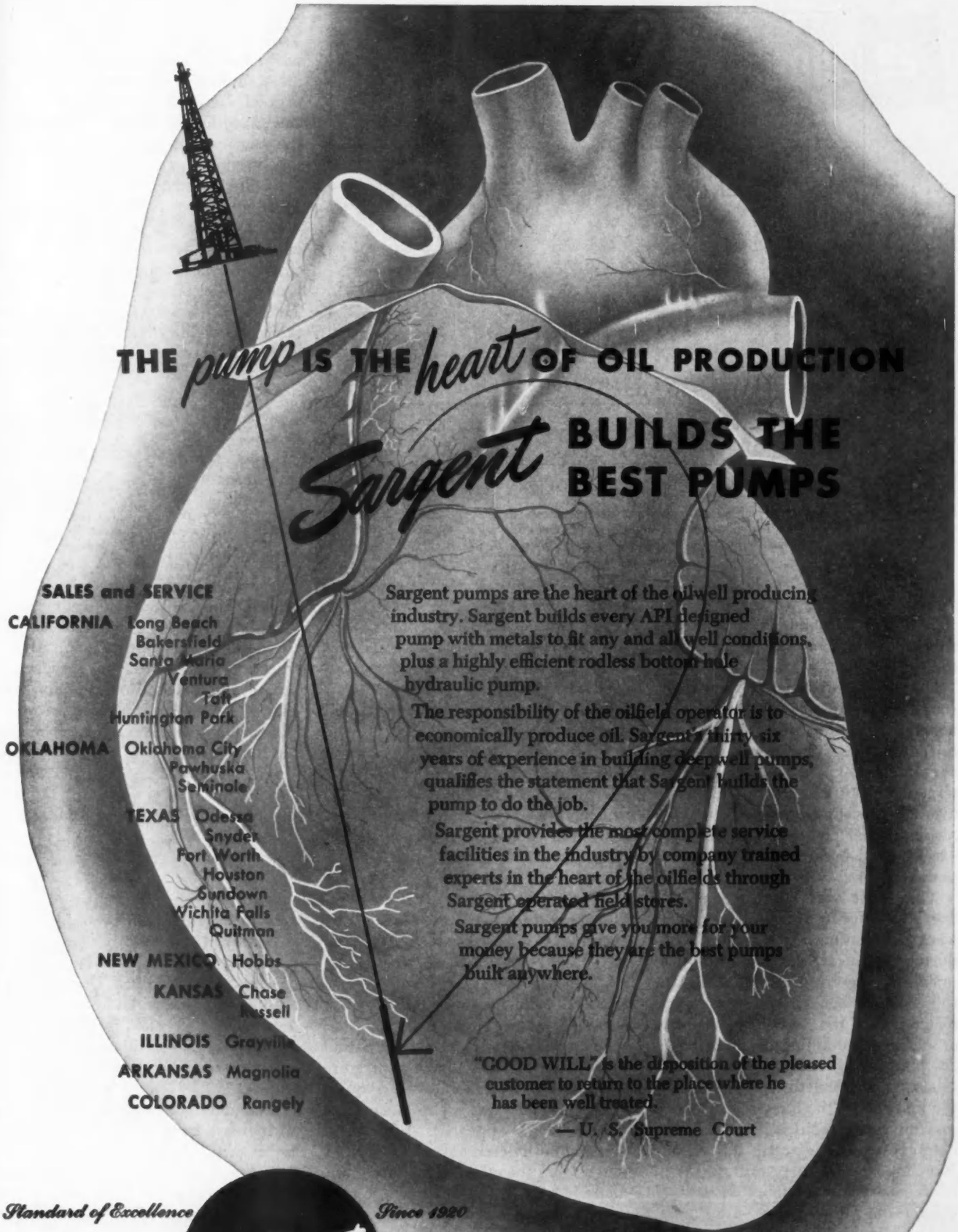
A ten percent increase in injection rate was obtained for well GW-9 as a result of using the detergent despite an average pressure decrease of 50 psi below that for the reference period. The average injectivity increase during detergent injection for all five wells was 19 percent.

It appears that the tight wells, GW-7, HW-4 and HW-5, benefitted more from detergent injection than did the loose well, GW-9.

The injection of about 50 ppm of a non-ionic detergent (weeks 20-32, Figure 3) was considerably more effective than the injection of 20 ppm (weeks 39-41) or the combination of 25 ppm of non-ionic detergent and 10 ppm cationic detergent (weeks 43-45) as part of the full-scale field test. Part of the decreased injection from the thirty-seventh through the fifty-second week, however, undoubtedly was caused by the decreased injection pressure.

Pressure-decline tests showed that there was an indicated temporary increase in the effective formation permeability to water for each of the wells. The skin factor of each well became more negative during the injection period, indicating that the improvement in effective permeability around the well bore exceeded that of the formation as a whole. Furthermore, the skin factor of each well remained more negative after the injection than before, indicating some extended improvement.

The increases in rates of injection obtained in the pilot, 5-spot test prompted tests of the effect of injecting detergent into all wells on the 720



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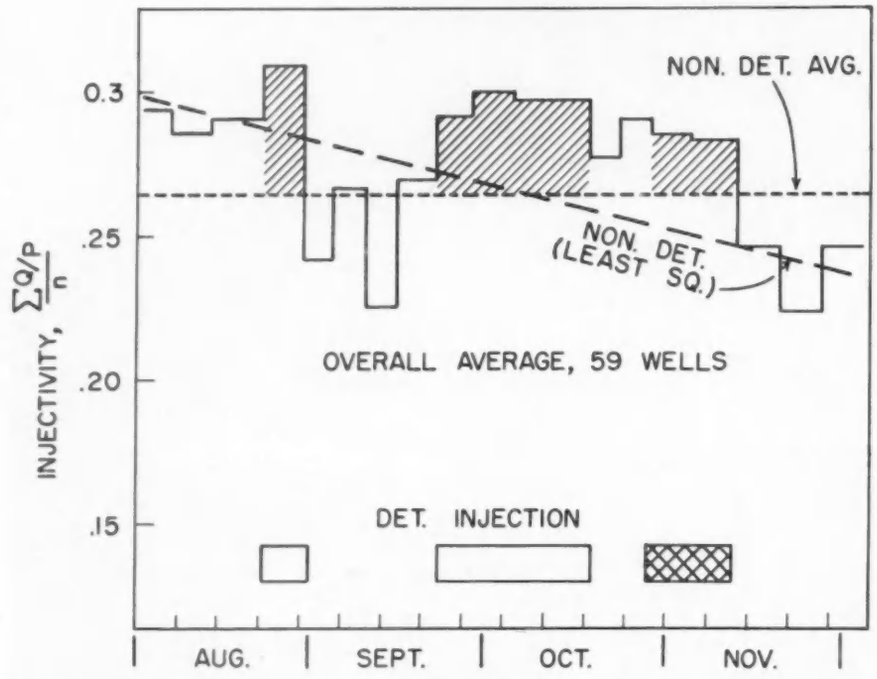

FIGURE 4—Average injectivity of 59 wells. Normal decline shown by "least squares" line. Each detergent injection resulted in an increase in injectivity. These data agree with those from the 5-spot test—"tight" wells generally more susceptible to improvement by detergent injection than "loose" wells.

acres of the property, on which there were a total of about 90 input wells. Detergent injection was begun during the thirty-fourth week.

During the first day (August 23) enough non-ionic detergent was metered into the intake line of the injection pumps to form a solution containing 150 ppm of detergent. Detergent injection was continued at an average concentration of 45 ppm for an additional eight-day period, then was stopped because of plant operational troubles.

The plant was restored to full operation during the thirty-seventh week. Operation appeared normal during the next week so detergent injection was resumed late in the thirty-eighth week. The detergent was metered into the intake line to form a solution containing an average of 20 ppm of detergent during the thirty-ninth, fortieth, forty-first, and the first half of the forty-second week.

A mixture of non-ionic and cationic detergents was injected during the forty-fourth and forty-fifth weeks at average concentrations of 25 and 10 ppm, respectively.

The effect of detergent use on the rate of injection into the field as a whole is difficult to evaluate because of complicating factors such as variations in pressure on the water-distribution system and necessity for manual control of injection rates into loose wells. Therefore, a reference period was selected beginning with the twenty-fourth week of 1954 and extending through the second week of 1955, excepting periods of detergent injection, as indicated by the dashed baseline.

Pressure on the water-distribution system during this period averaged 408 psi and the average injection rate into 65 wells was 5700 barrels daily. During the detergent-injection period, the injection rate averaged 6340 barrels daily at a pressure of 410 psi.

These results indicate that the overall rate of injection was increased 11 percent by the addition of detergent to the water. It is difficult to evaluate the benefits of using the mixture of cationic with non-ionic instead of non-ionic alone because, during that injection period (forty-fourth and forty-fifth weeks), injection pressure was above average (428 psi). Average injection rate was 6480 barrels of water daily. It appears that the effect of using both detergents did not differ much from the effect of the non-ionic alone.

Of the nine wells on which wellhead tests were made before and after the use of detergent, an increase in effective permeability was obtained in five wells and a decrease in four. Skin factors became more negative in five wells and less negative in two. They remained essentially constant in two.

Of the seven wells on which injectivity-index tests were made, three showed an increase in input capacity, three showed a decrease and one remained constant. These test results agreed with the changes observed in the permeability values and skin factors obtained on the wells.

Results indicate that effect of the addition of detergent to the water, discussed above, was of a temporary nature. The favorable balance in change of skin factors may indicate a prolonged decrease in skin factors. These results agree with those obtained in wellhead tests of a single-well and those of the 5-spot pilot tests.

Average injectivity values were calculated for four groups of wells with narrow ranges of injectivity. This grouping results in the following arrangement: (a) 14 wells operated at full pressure, Q/P less than 0.2; (b) 22 wells, Q/P less than 0.3; (c) 20 wells, Q/P between 0.3 and 0.7; and (d) 8 wells, Q/P greater than 0.7.

In each of the classes of wells, except in the eight loose wells, every addition of detergent was accompanied by an increase in injectivity. Injection rates into the loose wells had declined steadily except for periods of detergent injection. Most of this decline was the result of increased pinching of the loose wells in an attempt to maintain pressure on the distribution system while the number of input wells was being increased. Part of the effect was caused by decreased pressure on the injection system.

The effect of detergent on the average injectivity of 59 wells is shown in Figure 4. The normal decline in injectivity of these wells is shown by the least-squares line. The injection decline appears to indicate pressure sensitivity of the field as a whole and an approach to a fill up of voids in the reservoir in at least a part of the field.

Each detergent injection resulted in an increase in injectivity. These data agree with those obtained in the 5-spot test and show that the tight wells generally are more susceptible to improvement by detergent injection than are the loose wells. A summary of the effect of detergent injection according to classes of wells is presented in Table 1.

It was not possible to determine water-input profiles of the wells be-

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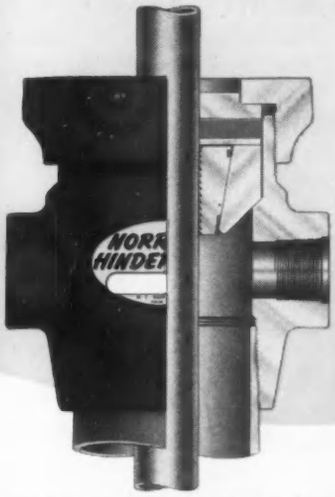
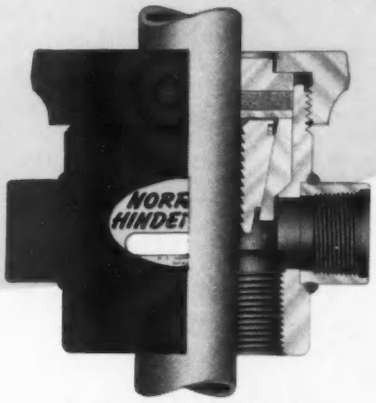
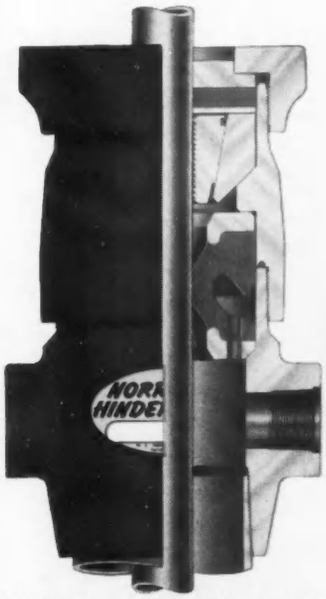


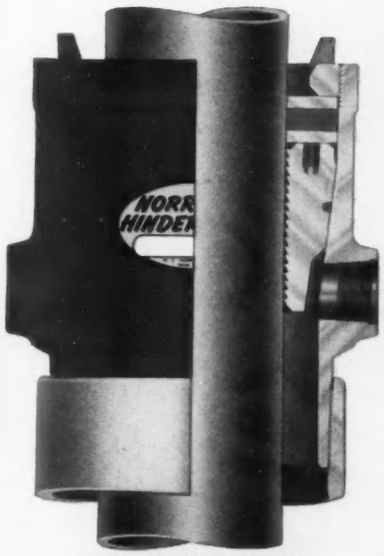
HW 2-in-1 TUBING HEAD
4000# Test Pressure
2000# C.W.P.



WCN TUBING HEAD
2000# Test Pressure
1000# C.W.P.



HW 4-in-1 TUBING HEAD
4000# Test Pressure
2000# C.W.P.



YLS CASING HEAD
2000# Test Pressure
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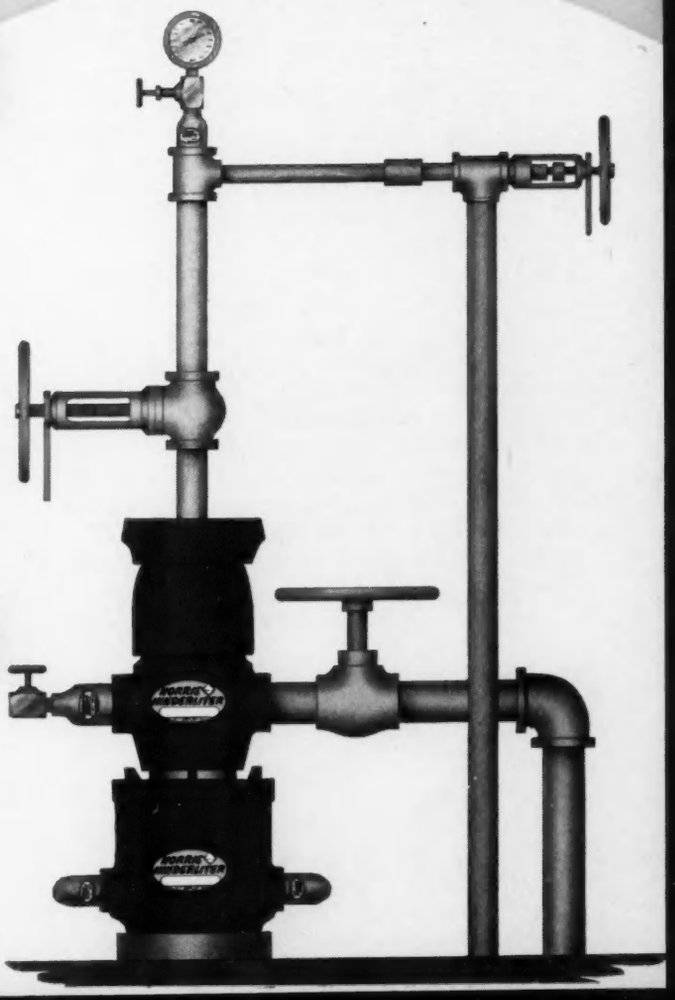

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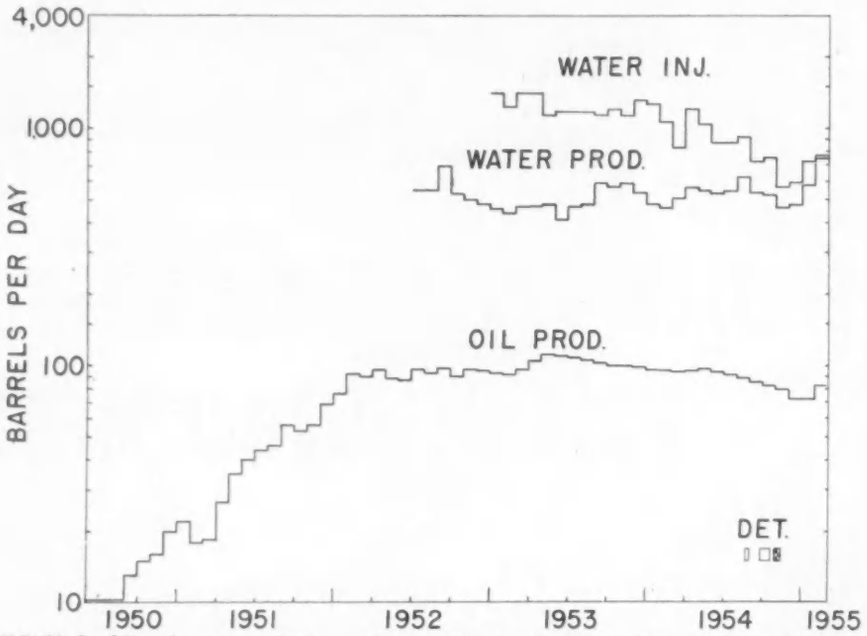

FIGURE 5—Oil and water production and water injection for Grover lease. Unfortunately, it is not possible to determine the proportion of oil production increase caused by detergent injection because of the installation of additional pumping equipment.

cause they were completed with 2-inch cement-lined tubing and instruments available for this test were of larger diameter. However, the greater effectiveness of detergents on the tighter wells indicates that the detergent solution penetrates part of the formation previously either inaccessible or impermeable to water.

No detergent was detected in samples of oil collected throughout the test although interfacial tensions by the pendent-drop method would be sensitive to very small concentrations of detergent. Measurements of the surface tensions of produced water samples, by the du Nouy ring method, also indicated that no detergent had yet moved through the formation.

Oil Production. The production record for the 80-acre Grover lease is presented in Figure 5. Rate of oil production increased sharply in 1951 as a result of the water-flood. Maximum daily oil-production rate was obtained in May, 1953, and thereafter declined steadily. The normal decline curve was established by the least-squares method, using data from May, 1953, through July, 1954. An appreciable change in oil-production rate occurred during November and December, 1954, and January, 1955, followed by a marked increase in February.

The amount of water injected during November, December and January was considerably less than that injected in preceding months. In February the amount of water injected into this lease was increased by installation of a third pump to maintain pressure on the water-distribution system at 1000 psi.

It is not possible to determine the proportion of the oil-production increase caused by detergent injection and that by increased water injection at higher pressures. The rate of oil production from the property is still increasing because of the recent development of this flood. Therefore, effects of the detergent injection on production of oil from this unit cannot be determined.

Conclusions

1. Detergent slug treatment caused significant injectivity increases in one water-input well and only minor changes in a second well. The rate of production from an adjacent oil well increased considerably after the detergent treatment.

2. Injection-rate increases averaging 34 percent were obtained in three tight wells during a pilot, continuous detergent-injection test.

3. Injection-rate increases averaging 11 percent resulted from the full-scale injection of a more dilute detergent solution.

4. Wellhead tests revealed that increases in effective formation permeability and improvements in skin factors were obtained as a result of detergent injection in most of the wells tested.

5. In general, increased injectivity following detergent injection appears to have been temporary. However, skin factors of some of the wells showed continued benefits.

6. Wells completed in relatively impermeable sand gave better response to detergents than did wells completed in more permeable sand, indicating that zones of the oil-productive sand previously inaccessible to injected water were penetrated by the detergent solution.

TABLE 1—Effect of Detergent Injection on Injectivity of Various Classes of Wells

Classification	Full Pressure	Tight	Medium	Loose	Full Field
Q/P range	0.2	0.3	0.3 to .7	0.7	0.01 to 2.0
No. of wells	14	22	20	8	59
Q/P					
Non-detergent	.101	.197	.418	.818	.267
Detergent	.110	.221	.453	.885	.295
Amount increase	.009	.024	.035	.067	.028
Percentage increase	8.9	12.2	8.4	8.2	10.5

ACKNOWLEDGMENTS

The cooperation of personnel of the Hoyt Oil Company in furnishing the property on which the described tests were made and comprehensive data concerning the property, and that of Hercules Powder Company in supplying the detergent used in the field tests are gratefully acknowledged.

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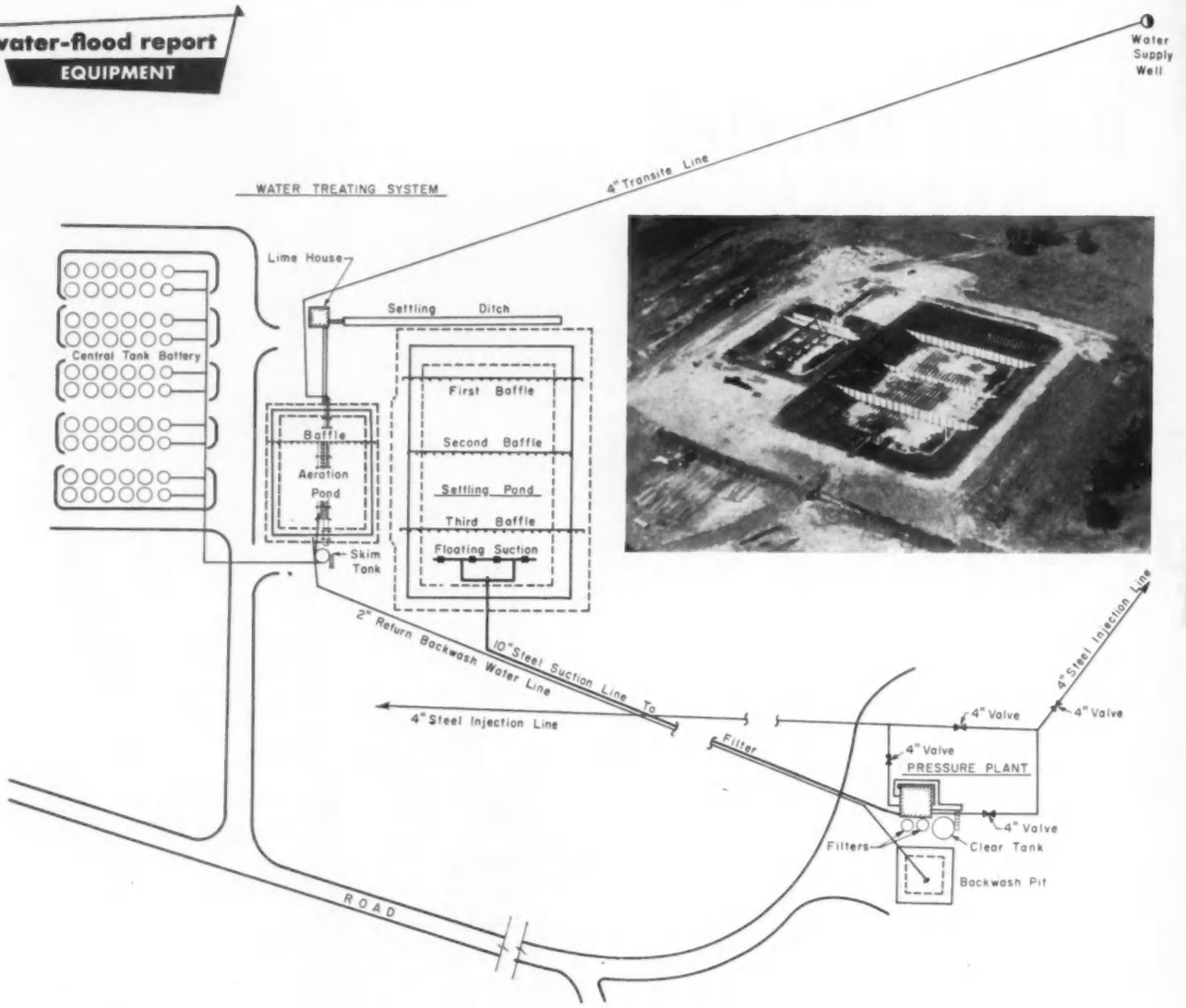


FIGURE 1—This system is designed to water-flood an estimated 600 acres of Bartlesville sand with approximately 36 feet of net pay at an average depth of 2450 feet. The anticipated daily injection capacity of the system is 10,000 barrels per day.

A Water-Flood . . . From the Ground Up

Much material, equipment and planning are involved in preparing water for injection. This system, presented step-by-step, illustrates one effective approach to the problem.

By WILLIAM H. McPHAIL
Tidewater Oil Company
Reece, Kansas

THE DESIGN and operation of an open-type water conditioning and injection system present a number of problems. Tidewater Oil Company's answer is shown in this description of its Hull "A & B" open-type system in the Sallyards field of Greenwood County, Kansas (Figure 1). This picture of a complete installation includes design, construction and operational information.

The purpose of this system is to water-flood an estimated 600 acres of Bartlesville sand that has approximately 36 feet of net pay at an average depth of 2450 feet. The anticipated daily injection capacity of the system is 10,000 barrels per day at 800

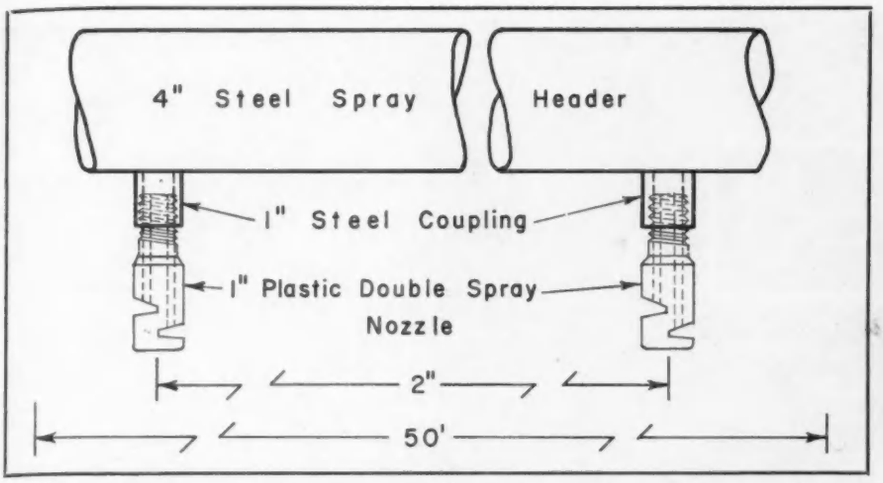


FIGURE 2—Double spray plastic nozzles screwed into 1-inch couplings at 2-foot intervals on a 4-inch steel header aerate the water.

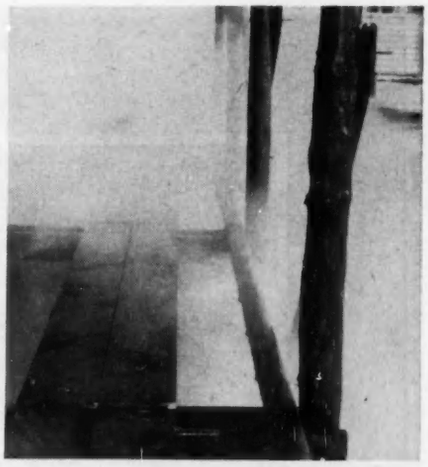


FIGURE 3—The 4-inch spray header rests on a redwood platform supported by treated poles set in concrete.

pounds per square inch pressure. Water supply is obtained from the Arbuckle lime formation.

Supply System. The supply water is produced from the Arbuckle lime formation from 2990 to 3570 feet. Eight and five-eighths inch casing is set at 2990 feet which leaves the producing zone open from 2990 to 3570 feet. The water is produced with a submersed electric pump set at 1800 feet on 4-inch steel tubing. With the pump producing at a rated capacity of 5500 barrels per day, the static water level is lowered from 530 feet to 600 feet, ground level measurement. The water travels from the wellhead through 650 feet of 4-inch transit pipe to a 4-inch steel spray header located in the aeration pit.

Treating System. Before the Arbuckle water is injected, the following treatments are made.

1. Aeration
2. Chemical treatment with lime
3. Detention
4. Filtration

In an open-type system, it is necessary that the hydrogen sulfide be removed from the Arbuckle water. This is accomplished by aerating the water with a spray system. Aeration is obtained with double spray nozzles that breaks the water into a mist. The plastic nozzles are screwed into 1-inch couplings that are spaced two feet apart and welded on a 4-inch steel header (Figure 2). Both the couplings and 4-inch header are epon coated to prevent corrosion. To obtain 25 psi pressure on the header, 25 double nozzles are used in aerating approximately 5500 barrels of water per day. Chemical analysis shows that all of the hydrogen sulfide is being removed with 25 psi pressure on the spray nozzle. The desired spray of the water is obtained by increasing or decreasing the pressure on the spray nozzle. This is accomplished by removing or adding nozzles to the header as required.

The spray header is supported by a redwood platform constructed on treated poles that are cemented in the ground in the aeration pit (Figure 3). The spray nozzles are located one foot above the operating water level in the aeration pit which allows the water spray to travel approximately 15 feet in the air before coming in contact with the surface of the water. To prevent carry-off, corrugated asbestos baffles are secured to the treated poles which extend six feet above the header platform (Figure 4).

The supply and produced water is collected in the aeration pit which is 50 feet x 90 feet x 5 feet measured at the base of a 2-1 inside slope. To prevent water seepage, the aeration pit is lined with an asphaltic base material that is prefabricated in sheets 2 feet wide, 12 feet long, and ½-inch thick. The sheets are butted together and sealed with a strip that is 8 inches wide and ¼-inch thick which is similar to the lining material. The strip is cemented to the lining with a hot asphaltic base cementing material.

A central tank battery for all the water-flood leases is located approximately 150 feet from the aeration pit. The produced water from the tank battery is skimmed in a 200-barrel wooden tank to remove any oil that might be carried through the gun barrel, in the tank battery (Figure 5).

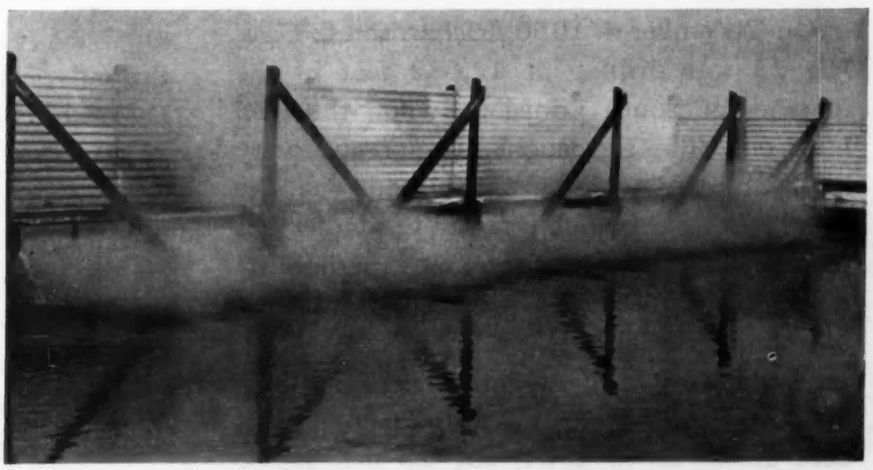
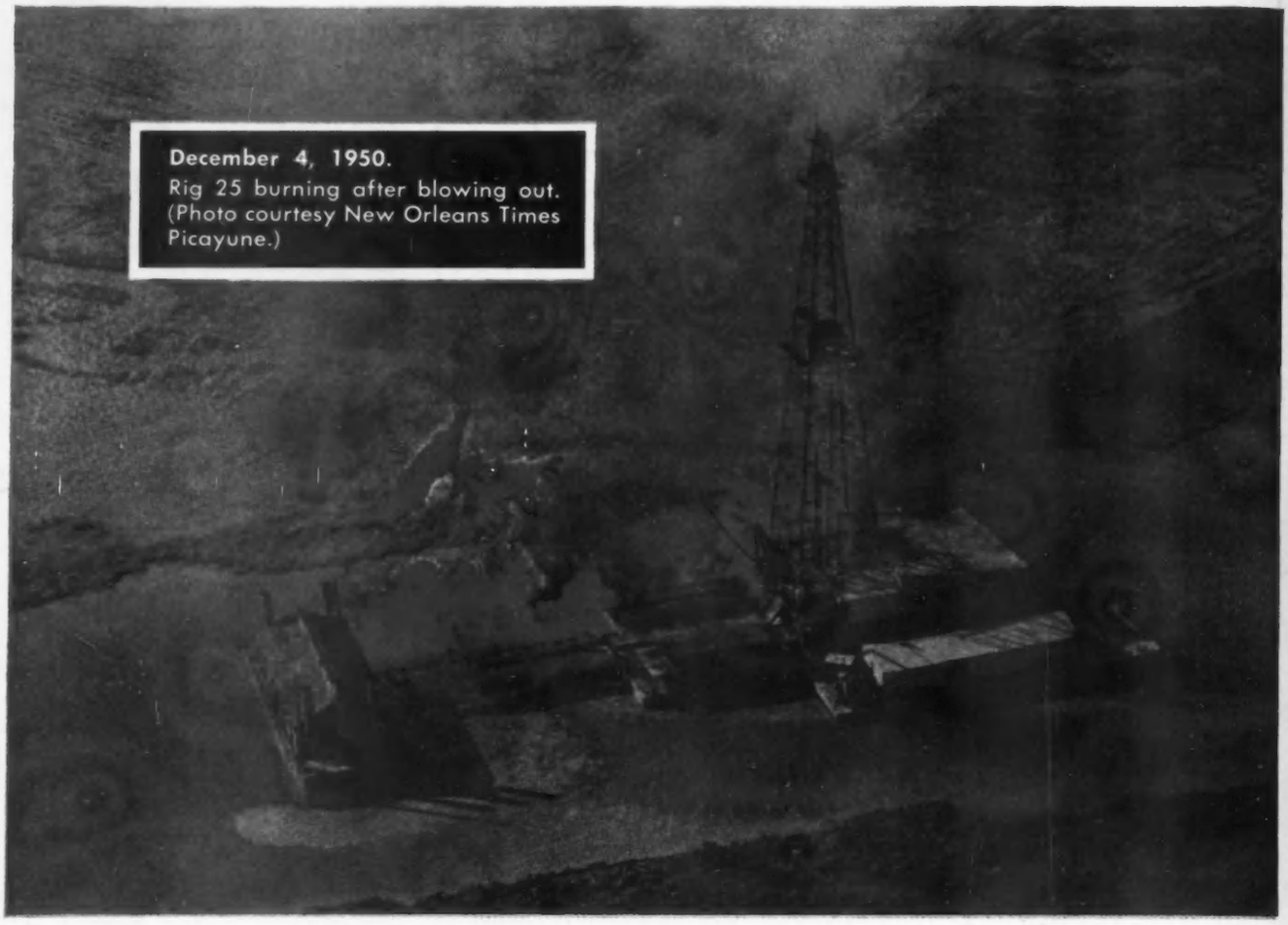


FIGURE 4—Corrugated asbestos baffles secured to the treated poles prevent excessive water carry-off.



December 4, 1950.
Rig 25 burning after blowing out.
(Photo courtesy New Orleans Times Picayune.)

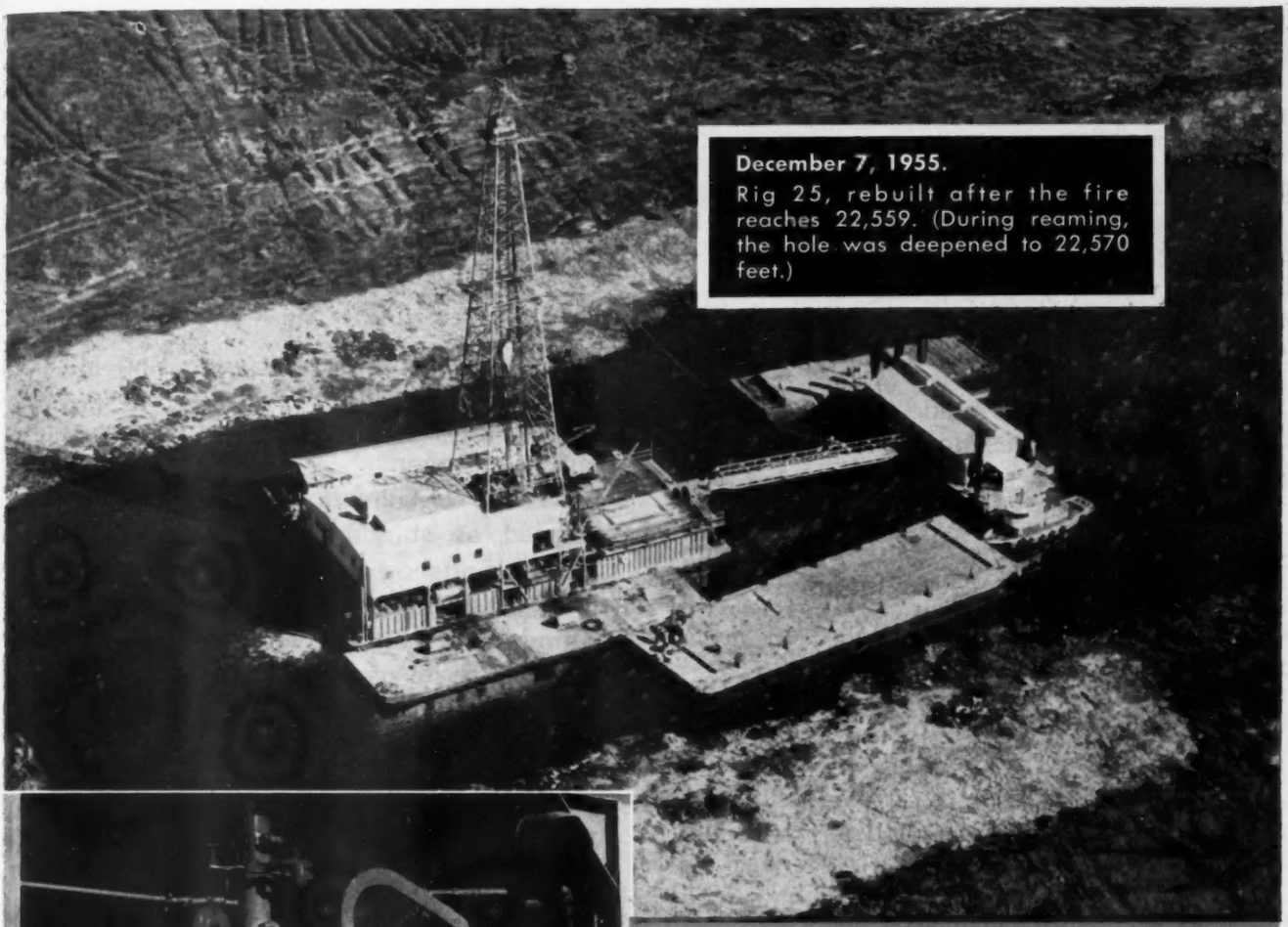
how this well fire paved the way for drilling the deepest well in the world

On December 4, 1950, Richardson & Bass' Rig 25 was drilling at 11,682 feet in the marshes of South Louisiana when the well blew out. The rig caught fire and was very badly burned. This fire pointed out the desirability of an effective way to remove gas from drilling fluids, and the first experimental model of the SWACO D-Gasser was installed on rebuilt Rig 25 on May 17, 1951.

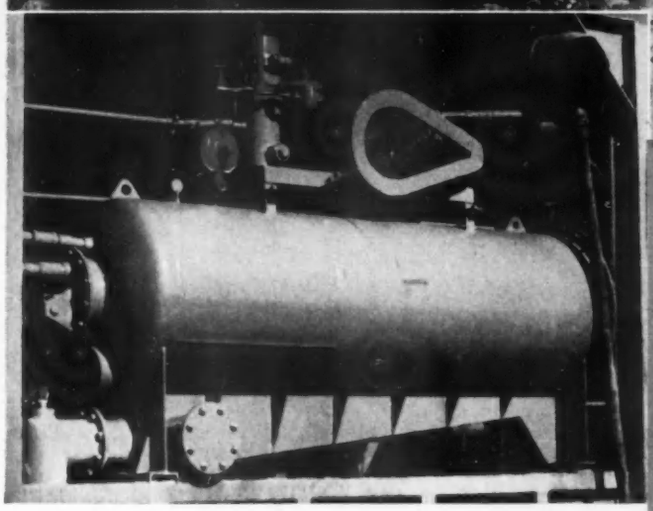
The D-Gasser marked the beginning of a new era in safety for operators in high pressure areas. Since 1951, Rig 25 has drilled many marshland wells without fire or blowout. While much credit for this performance must go to Richardson & Bass equipment, drilling personnel, and mud engineers, the D-Gasser certainly played a vital part.

SWACO D-Gassers are now standard equipment on all Richardson & Bass Gulf Coast rigs as well as many rigs of other Gulf Coast operators.

By removing all the gas from all the mud as it is circulated, SWACO D-Gassers have prevented many blowouts and fires. Some leading operators have said that D-Gassers have made possible the drilling of many wells that could not have been drilled otherwise.



December 7, 1955.
Rig 25, rebuilt after the fire reaches 22,559. (During reaming, the hole was deepened to 22,570 feet.)



This SWACO Mud D-Gasser is installed on Rig 25. It was inspired by the 1950 fire and was given much credit for helping keep the deep well under control.

HERE'S HOW THE SWACO D-GASSER HELPED IN DRILLING THE WORLD'S DEEPEST WELLS

- Saved hundreds of thousands of dollars in mud costs.
- Saved untold hours of rig time that would have been lost while building up mud weight.
- Permitted the reasonably safe use of over 16 lb. mud for over two months while drilling in treacherous open hole from 13,656' to 19,752'.
- Made it possible to tolerate continuous gas-cutting from about 13,656' to bottom. This allowed the use of drilling mud on the lighter side of the mud balance to avoid lost circulation and sure loss of hole.

THE DEEP HOLE

The SWACO D-Gasser played an important part in drilling the deepest well in the world which was recently made into the deepest producer. This well is an outstanding example of how the D-Gasser can save holes as well as time and money.

J. E. Hill, General Manager for Richardson & Bass, said the record would never have been attempted without the D-Gasser. Actual experience proved the soundness of this judgment.

At a number of points before reaching 19,572 feet, mud was gas-cut from 17.9 to 13 lbs. per gallon and lower. This could easily have been a major emergency without the D-Gasser because it would have been nearly impossible to control the mud within the

narrow range of weights required. In most instances, the difference between blowout and lost circulation was only three-tenths of a pound per gallon.

THE BIG TEST

The big test, however, came just as the hole was at 21,463 feet, when 18 lb. mud was severely gas-cut to 11.9 lbs. per gallon. The D-Gasser continuously restored the mud to its original gas-free weight.

Two considerations made it imperative to avoid weighting the mud any more than necessary.

First, it was difficult to maintain the lime base mud under the high temperatures being encountered. Adding weight material would have compounded the difficulty.

Second, it was essential to avoid any possibility of lost circulation because, at this depth, lost circulation would have meant almost certain loss of the hole.

With the D-Gasser, it was possible to tolerate gas-cutting continuously from the bottom of the 9⅝" protection string at 13,656 feet, to T. D. at 22,570 feet. This permitted holding the mud weight only slightly above the indicated bottom hole pressure encountered as drilling progressed. If the D-Gasser had not been available, this would not have been possible, and the chances of losing the hole due to lost circulation would have increased enormously.

HOW THE D-GASSER CUT COSTS

The total drilling mud bill was $630,-811.95. Since there was no control well for comparison it is impossible to tell just how much the D-Gasser saved in mud costs.

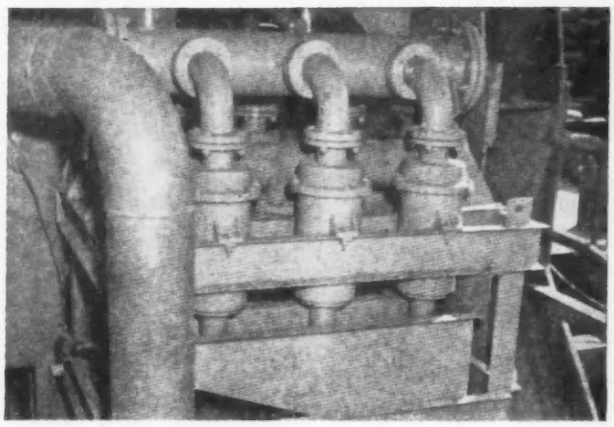
However, over 1,000 wells have been drilled using the D-Gasser and many reasonably accurate comparisons have been made.

Based on this experience, it can safely be said that the mud bill without the D-Gasser might have been more than one million dollars—*if the well could have been drilled at all.*

Based on the same experience, it is certain that the D-Gasser saved many hours of rig time.

Richardson & Bass has not lost a rig due to blowout or well fire since SWACO D-Gassers have been installed. Savings in mud costs and drilling time alone have been enough to pay the entire cost of the D-Gasser many times over.

SWACO D-Gassers are rapidly becoming accepted as standard equipment for Gulf Coast and offshore rigs, as well as rigs operating in other high pressure areas. If you are drilling in such an area and are not using the D-Gasser, write us. It is possible that it can save your money as well as protect your rig investment.



The DORRCO D-SANDER effectively removes sand and drilled solids from the drilling fluid. Extensive field experience has proved that it speeds drilling, reduces pump maintenence costs, and offers many other important benefits. A D-Sander is installed on Rig 25 to reduce the cost of drilling through the sands that predominate in South Louisiana above 9,000 feet. For full information on this outstanding piece of equipment, call or write us.

SWACO

SALT WATER CONTROL Inc.

A Sid Richardson Development Company

1211 Ft. Worth National Bank Phone: ED 2-4434 Ft. Worth, Texas

FIGURE 5—A 200-barrel wooden tank is used to skim produced water of any oil that is carried through the gun barrel.

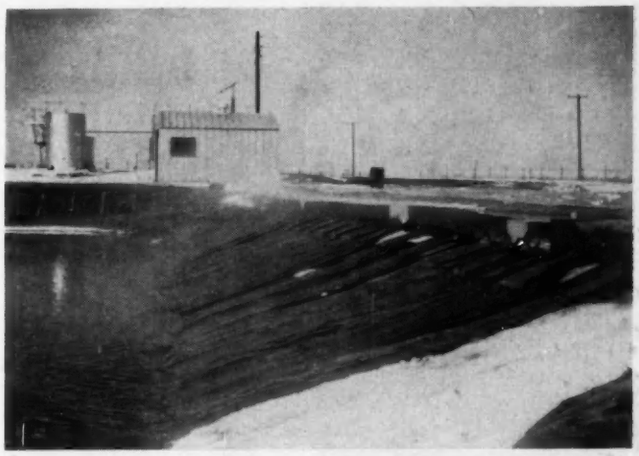


FIGURE 6—From the chemical building water gravitates to the settling pit. Spaced cement blocks allow even distribution of the water.

After the water has been skimmed in the wood tank, it is splashed aerated on the platform of the spray system. A corrugated asbestos baffle that is 42 inches in width is secured to treated poles which extends across the width and 25 feet from the outlet end of the pit. The baffle is located 18 inches above the bottom of the pit and extends one foot above the operating water level. The purpose of the baffle is to skim any oil that might get through the skim tank and to cause the water to travel down and up before leaving the pit. It is felt that better settling of the sulfide precipitate is obtained when the water is forced to travel to the bottom and back to the top before leaving the pit.

The water travels from the aeration pit in an 18-inch x 18-inch open cement ditch which goes through the inside corner of a 16-foot x 16-foot x 8-foot prefabricated steel chemical building (Figure 6). Inside the building, lime is fed into the stream of water with a dry type chemical feeder to control the pH and carbonate supersaturation. The water gravitates from the chemical building into an open ditch 18 inches deep and 6 feet wide, which is lined with the same lining material as the aeration pit. The dry lime is mixed with the water as it passes over, through and around cement blocks placed in the ditch. Settling time in the ditch allows the majority of the lime residue to settle out before entering the settling pit. This permits cleaning the residue from the ditch without any downtime of the system which would be required if allowed to settle in the settling pit. Cement blocks are spaced 1 inch apart between the ditch and settling pit which causes the water to enter across the entire width of the pit.

The settling pit is 80 feet x 190 feet x 10 feet measured at the base of a 2-1 inside slope. To prevent water seepage, the pit is lined with the same material as was used in the aeration pit. The system has three days detention time when it is operated at full capacity. There are three corrugated asbestos baffles extending across the width of the pit that are secured to treated wood poles cemented in the ground (Figure 7). The first and third baffles are 6 feet wide and spaced 18 inches above the bottom of the pit. The joints in the baffle are caulked to prevent water from seeping through. The second baffle is 42 inches wide, and set on the bottom of the pit. The joints along the bottom of the baffle are caulked which forces the water to travel over the top. As the water travels from the inlet to the outlet end of the pit, it is caused to travel in a downward, upward, downward, and upward path before entering a floating suction. The floating suction is supported by eight 55-gallon drums (Figure 8). The water enters the suction through slots in the bottom of a 5-inch steel pipe that is 60 feet in length. The 5-inch pipe is teed on

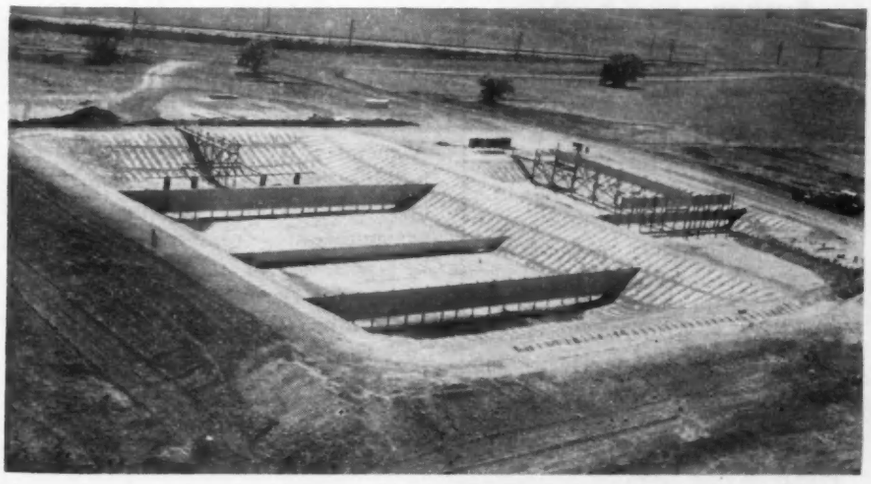


FIGURE 7—Three corrugated asbestos baffles force the water to travel an over-and-under path from inlet to outlet.

FIGURE 8—Floating suction is supported by eight 55-gallon drums. Ell connections allow the suction line to be moved up or down.

FIGURE 9—A permeable plate type filter charged with graphfilter media is used to filter 5000 barrels of water a day. Clear water is stored in the wooden tank.

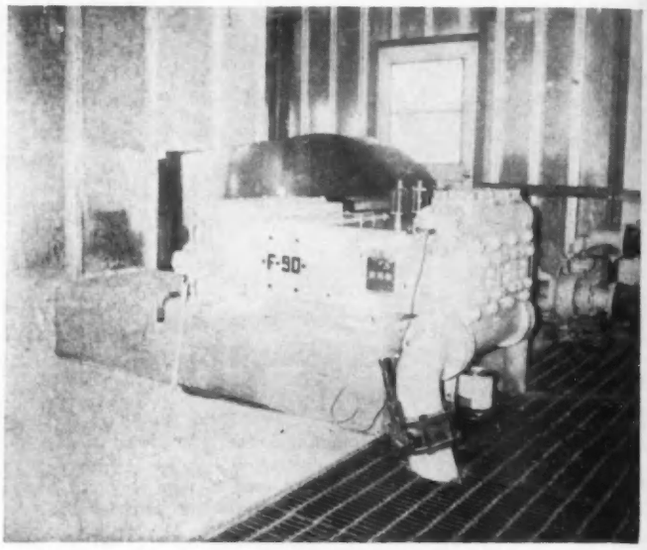


FIGURE 10—The injection system is designed for two triplex pumps. At present, however, only one is required.

two joints of 7-inch steel pipe which are ell connected to a main 10-inch discharge line. The ell connections allow the suction to be raised or lowered. The water travels by gravity from the settling pit through 900 feet of 10-inch steel pipe to the injection plant for filtration. To obtain 10,000 barrels per day filtration, two 8-foot x 3-foot, 6-inch permeable plate type filters charged with graphfilter media will be used (Figure 9). Since the system is operating at approximately 50 percent capacity, only one filter has been installed. The filter is backwashed daily with a 5-inch x 4-inch centrifugal pump. The backwash water is pumped into a backwash pit which is 30 feet x 30 feet x 5 feet measured at the base of a 2-1 inside slope and lined with the same material as the aeration and settling pit. The water is allowed to settle and is then pumped with a 1½-inch x 1½-inch centrifugal pump to the aeration pit through a 2-inch steel line. The filtered water is stored in a 16-foot x 16-foot wood clear tank to be used for injection and backwashing of the filter.

Injection System. The injection system is designed for two triplex pumps that will inject approximately 11,000 barrels of water per day at 800 psi pressure. Due to the present injection requirement, only one pump is in operation (Figure 10). The pump and controls are located in a 24-foot x 24-foot x 8-foot prefabricated steel building. A triple rated electric motor that can be wired to obtain 40, 70, and 100 horsepower is used to operate the injection pump. Water is pumped to the field through a 4-inch steel line with 2-inch lines extending to the individual wells. Where possible, the water meters are grouped along the trunk line so that 2, 3, and 4 meters can be read at one location.

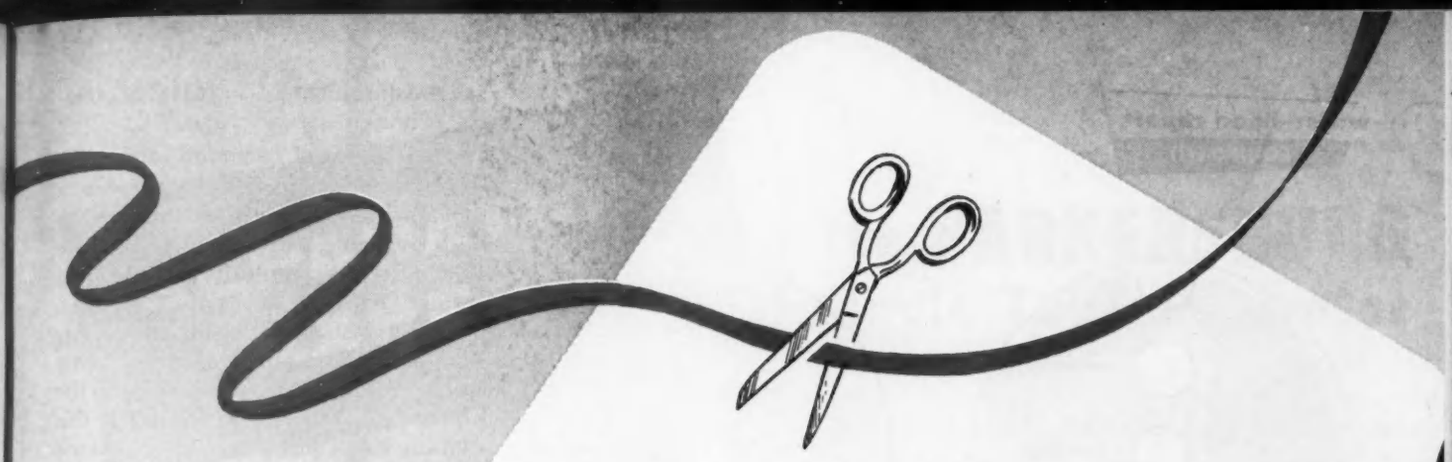
Pressure and Water Level Controls. Safety devices used through the system consist of high and low mercury switches on the discharge of the injection pump that shuts the pump motor off when the pressure gets higher or lower than the switch setting. A low lube mercury switch is installed on the oil pressure system of the injection pump that shuts the motor off should the pressure become lower than the switch setting. A 2-inch shear pin pressure relief valve is installed on the high pressure side of the injection pump. If the pin is sheared, the water will bypass into the wood clear tank and the pump motor will be shut down by the low pressure control. The desired field pressure is maintained by opening or closing a 2-inch bypass valve from the four inch injection line to the clear tank.

High-low level liquid electrodes are installed in the wood clear tank that will shut the pump motors off when the water level gets below the lower electrode setting. The pumps will remain off until the water level reaches the upper electrode which is spaced four feet above the lower. If the pump motor is shut off by any of the safety devices, a siren warns the plant operator or personnel familiar with the confrols so that they can make corrections for the failure immediately. A metal partition is installed in the building between the injection pump and the electrical equipment. This prevents water from coming in contact with any of the electrical equipment in the event of a high pressure leak in the building.

A field water analysis laboratory is located in the building where weekly tests are made on the filtered water for carbonate supersaturation and pH. The analysis of the tests controls the amount of lime to be fed into the water stream. —**The End**

About the Author

WILLIAM H. McPHAIL is an area engineer for the Tide Water Associated Oil Company in Reece, Kansas. His duties include the secondary recovery of oil by water-flooding, located in the Sallyard and Blankenship pools. After receiving his B.S. degree in petroleum engineering from the University of Houston in 1949, he became field engineer with Tide Water in Kamay, Texas, in the primary production of oil and gas.



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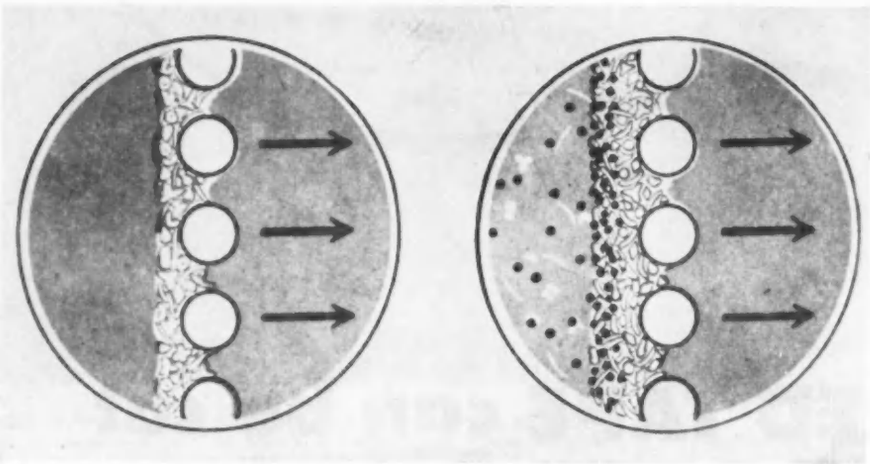

FIGURE 1—Fine, highly porous powder deposited on a permeable septum forms a fine filtering surface. At left, the initial filter cake, the pre-coat, is forming against the permeable septum. At right, to prevent formation of a slimy cake on the pre-coat surface, additional diatomite continuously is metered into the water before filtration.

Some tips on . . .

Diatomite Filters

Design, selection, operation and advantages—here is first-hand information.

By G. R. BELL and T. M. JACKSON, JR.
Johns-Manville Products Corporation, Manville, N. J.

DIATOMITE FILTERS can reliably and economically provide water of superior quality when the selection of equipment, filter aid and installation design receive careful attention from competent engineers. The proof of this is found in the growing number of such filters in flooding operations.

Briefly, the object of a water-flood treatment plant is to prepare the water in such a way that it can be injected into the reservoir in sufficient quantity and at low enough pressures to accomplish the purpose of the flood. In practice, this usually means treating the water so that the formation does not become plugged.

Water treatment adequate to accomplish this goal for a specific flood varies over a wide range depending on the nature of the water supply and the characteristics of the formation into which the water is to be injected. It is a rare case indeed that water is injected without some treatment. Depending on the variables above, it is usually subjected to one or more of the following:

1. The control of bacteria by . . .
   - Chlorination
   - Organic bacteriacides
2. Removal of sediment and/or turbidity by . . .
   - Sedimentation
   - Flocculation and Sedimentation
   - Flotation
   - Filtration
3. Removal of dissolved gases and solids by . . .
   - Aeration
   - Desorbtion or absorbtion
   - Chemical treatment
4. Control of corrosion by . . .
   - Removal of corrosive substances by one of the methods above
   - Adjustment of acidity or alkalinity
   - Addition of corrosion inhibitors.

It is not intended to present a complete listing of the different methods available, but merely to indicate the possible complexity of adequate water treatment.

Several of the foregoing treatments are common to almost all plants. One such treatment is filtration, and the balance of this article will cover this vitally important phase of water purification.

Filtration usually follows other treatment methods that may be used. Its purpose is to remove undissolved solids. Two general types of filter equipment are used in water-flooding plants:

- Those having beds of graded sand or anthracite.
- Those in which filter aid such as diatomite is used.

Sand filters, of either gravity or pressure type, can normally produce polished water only if the water has received some form of prior treatment to coagulate the turbidity-forming particles completely. Such treatment requires close control of pH and alkalinity for satisfactory performance. Such control may be a practical impossibility in the case of many highly buffered brines.

A number of sand filters are in service on water which has not been pretreated. Although the relatively coarse suspended solids may be removed, the sand or anthracite beds are not fine enough to remove more than a part of the microscopic particles which make up the turbidity.

Many operators have become dissatisfied with the degree of clarification attained by sand filters and have installed, or are evaluating, another type commonly referred to as the diatomite filter.

Diatomite, or diatomaceous earth, filter aids are extremely fine, highly porous powders. When deposited on a permeable septum such as a filter cloth, they form a fine filtering surface. Figure 1 shows on the left a diagrammatic sketch of this initial filter cake, called the precoat.

Naturally, with removal of turbidity, if the particles form a slimy cake on the surface of the precoat, the flow of water will be sharply reduced. To prevent this, additional diatomite is continuously metered into the water before filtration. When filtered out

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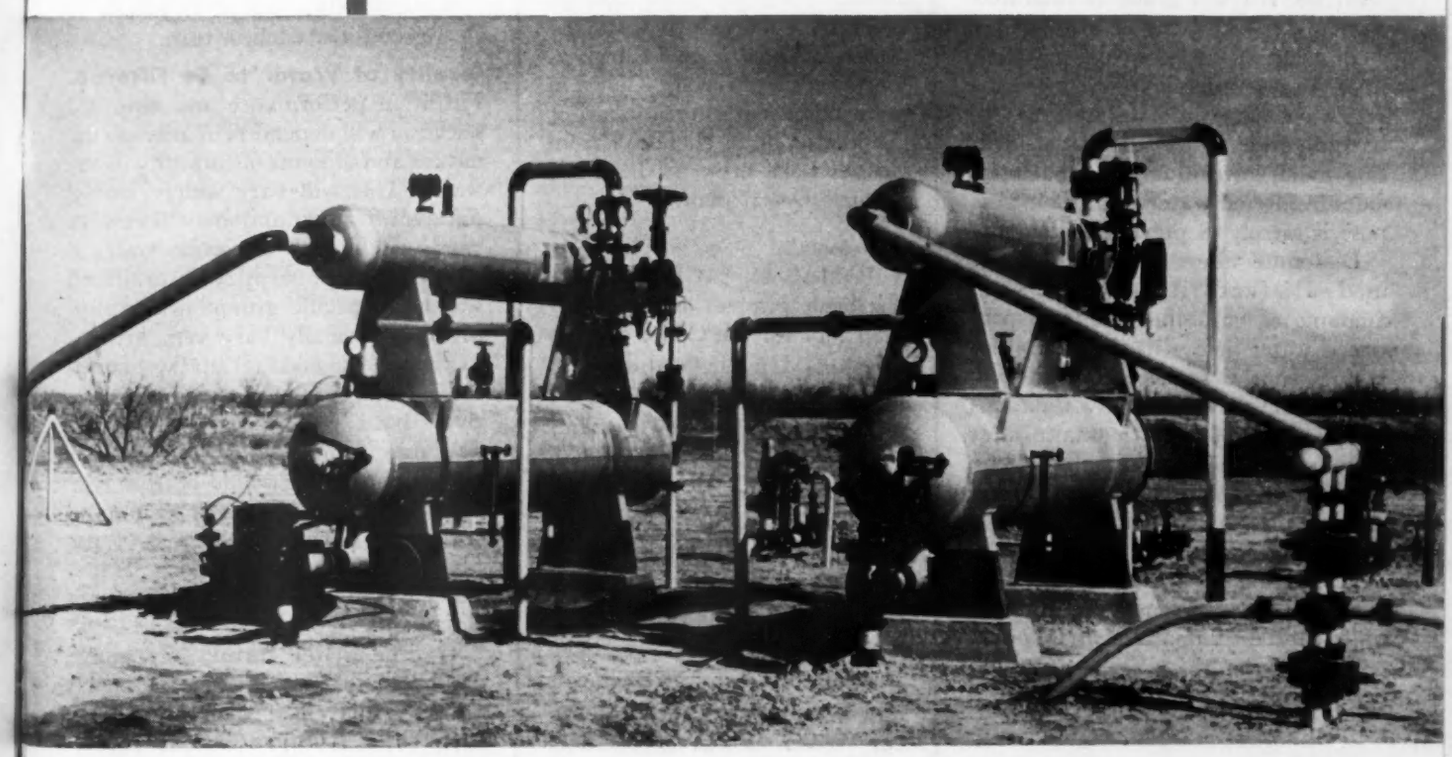

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on the precoat, this so-called body feed maintains the high permeability of the cake as filtration proceeds. The amount of body feed can easily be varied to accommodate changes in water quality, seasonal or otherwise.

The diatomite filter cake described above can be likened to a microscopic sieve. When water is filtered through this bed removal of turbidity approaches 100 percent; in addition, even a substantial proportion of bacteria may also be removed.

Doscher and Tuttle have reported in a recent paper[1] that plots of permeability vs. throughput in core tests showed that after injecting 9000 liters of anthracite-filtered water per square meter of surface area, the permeability had been reduced from a peak of 80 down to 60 millidarcys and was still going down. A similar test with the same water after filtration through a diatomite filter showed that the peak of 166 had been reduced to 146 millidarcys, but that the slope of the curve had levelled off. Their tests showed further that the anthracite-filtered water contained 0.03 parts per million of colloidal material, while the diatomite filtered water contained 0.005-0.02 ppm. These results were obtained with the coarsest grade of diatomite available.

In addition to removing turbidity, finer grades of diatomite are regularly removing appreciable amounts of bacteria from water, thereby permitting much lower dosages of bactericides in filtered water since their purpose is merely to prevent reinfection.

Diatomite filters can likewise be used satisfactorily to remove small amounts of emulsified oil from produced water before its injection. Operators in the southern California fields, particularly, have used this unique property of diatomite filter aids to remove up to 150 ppm of oil successfully, and in the same operation to remove turbidity and suspended solids.

The significant advantages for diatomite filters over sand or anthracite units can be summarized as follows:

1. With the same water, diatomite filters provide superior polish and clarity.
2. Since new, clean diatomite is used for each cycle, there is no danger of progressive balling-up of particles which form channels through which unfiltered water can pass. Likewise, there is no possibility of forming a breeding ground for bacteria.
3. Diatomite will not only perform satisfactorily on waters containing emulsified oil, it will actually remove most of it.
4. If, for some reason, the filter receives a heavy slug of suspended solids or turbidity, instead of upsetting the cake and channeling unfiltered water through to plug the formation, the diatomite cake itself will plug, and only the filter need be cleaned, instead of the well bore.

Since for the foregoing reasons diatomite filters are now receiving such wide attention from producers, it is felt that some tips on their successful operation are in order.

The following factors will affect the design and continuous satisfactory performance of a diatomite filter station:

1. Nature of the water to be filtered, and degree of clarity required in the filtered water.
2. Design and materials of construction of the filter equipment and its auxiliaries.
3. Selection of the grade and amount of filter aid to be used.
4. Design flow rate of the filters.

Let us consider each in turn.

Quality of Water to Be Filtered. Filtration performance and filter aid selection will depend primarily on the nature and amount of turbidity in the water. This will vary widely among different waters, and may likewise vary widely with the same water if it is a surface supply or produced water. A specific ground water supply will normally vary very little.

Particles making up suspended solids or turbidity are sometimes relatively hard and rigid. When filtered out, they form a fairly porous cake. Water containing solids of this type can be filtered with a minimum of body feed, perhaps as little as ½ per filter aid per part of turbidity. Sometimes filtration with only a precoat is practical.

On the other hand, soft, slimy, compressible particles form a nearly impervious cake when filtered. In such cases, adequate body feed is mandatory to obtain economical cycles. In the most severe cases, body feed of 20 parts filter aid per part of turbidity may be required. Generally, however, the dosage is in the range

About the Authors

Bell

Jackson

G. RICHARD BELL is senior research chemist in the Celite Application Research section of the Johns-Manville Research Center at Manville, N. J. He joined the company in 1942 as a sales representative for the Celite division. Bell has been actively concerned in his specialties, diatomite and related filter problems, writing several papers on the subject. Precoat filtration is one of the most recent initiated projects with which he has been interested. Bell was graduated from La Verne (California) College. After college, he was associated with the American Potash and Chemical Corporation of Trona, Calif., in connection with a process for the extraction of chemicals from Searles Lake brine at the firm's Mojave Desert plant.

THOMAS M. JACKSON, JR., has been product manager for filter aids for the Celite division of Johns-Manville Products Corporation since last year. In 1951 he joined the company as a staff engineer. Prior to affiliating with Johns-Manville he had been a sales engineer for Fletcher Works, Inc., of Philadelphia. Active in industry affairs, Jackson is vice chairman of the New York section of the American Institute of Chemical Engineers and is a member of the American Water Works Association. He received his B. S. degree in chemical engineering from Cornell University.

from 1 to 5 parts per part turbidity.

Most water supplies fall somewhere between these extremes. Unfortunately, the filterability of a given water cannot usually be predicted from the amount of suspended solids or turbidity present. In general, pilot-scale filtrations should always be run on the specific water to be handled, unless the water is known to be similar to water previously filtered. Such pilot-scale filtrations before plant construction would have prevented several failures of diatomite filters reported in the trade. In these cases, the filters installed usually had too little filtering area.

Another important water quality which should receive careful consideration is its corrosive tendency. Although the filter aid itself and the filtration process are relatively unaffected by corrosive water, failure to appreciate and design against corrosive action on filter equipment has been responsible for more dissatisfaction with diatomite filters than any other factor. This is discussed later.

Equipment Design and Selection. Diatomite filters have been in use for a wide variety of industrial filtrations for over 40 years. Certainly this is proof that diatomite filtration, properly applied for a specific type of service, has been uniformly successful.

Most industrial filtrations, however, involve the removal of relatively large quantities of suspended solids from relatively viscous liquids as compared with water. Flow rates are therefore usually lower than is common in water filtration. Furthermore, the materials of construction are frequently different than would be recommended for water or brine service. As a consequence, some dramatically unsuccessful attempts have been made to adapt industrial filters directly to water filtration, without giving proper consideration to the vastly different service conditions encountered.

In the last decade, an increasing number of filter manufacturers have introduced entirely new types of units or complete redesigns of older units. Several of these have concentrated almost entirely in developing equipment suitable for service conditions peculiar to oil field water-flooding.

These filters are of two general types:

- Vertical tank, tubular element, backwashing filters.

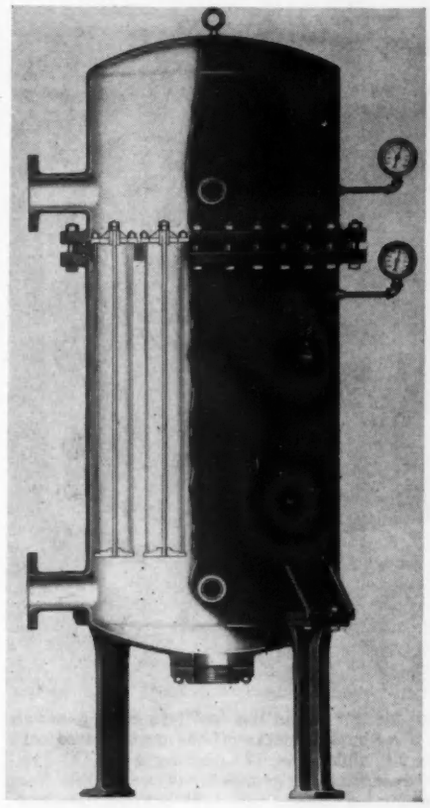

FIGURE 2—Cutaway view of a vertical tank, tubular element, backwashing filter. This design first was developed in U. S. during World War II.

- Horizontal tank, vertical flat leaf, sluicing filters.

A cutaway view of the first type is shown in Figure 2.

This design was first developed in this country by the military for portable water-treatment plants during World War II. Water enters at the bottom of the filter, flows through the porous walls of the tubular elements, passes up the inside of the tubes through the tube sheet, and out the outlet. The dome above the outlet provides a cushion of entrapped air. At the end of the cycle, a quick-opening valve in the drain line is tripped and this cushion expands rapidly, forcing water backward through the tubes in an explosive bump. This knocks off the accumulated cake which is then carried out as the filter drains.

Several other satisfactory methods have been developed to give this accelerated "air-bump" backwash. Generally, filters designed without some means of accelerating the backwash flow during cleaning have given poor service in oil field floods. Mere reversal of flow without this rapid, explosive acceleration will not usually provide satisfactory cleaning, and progressive plugging of the tubular elements takes place.

In a recent paper,[2] Bell has described in considerable detail the various types of these filters now on the market. The leaf type of filters now offered for oil field service are all generally similar to that shown in Figure 3.

In this filter, a series of flat leaves is mounted on a manifold. The leaves consist of a drainage chamber covered by either metal or fabric filter cloth. Filters of this general type have been used for years in industrial filtrations. For water service, however, the drainage chamber inside the leaf must be larger to permit the higher flow rates and low pressure differentials required for economical water filtration.

Unfiltered water enters the side of the tank, passes through the diatomite cake built up on the filter cloth, and into the chamber from which it flows into the manifold and out.

At the end of the cycle, in units such as the one shown, the tank is drained, and the cake sluiced off to the drain by water-spray nozzles located along the top of the tank. Some of these filters are so designed that the leaves rotate past a single set of nozzles; in others the leaves are stationary, and multiple sets of nozzles are so arranged as to cover the whole filter area. Other cleaning methods now under consideration include air-washing and high-frequency vibrations to knock off the accumulated cake.

Whatever type is chosen, the materials of construction used in the filter must be selected with regard to the prevention of all types of corrosion. Electrolytic corrosion, in particular, has caused difficulty because of the lack of proper insulation between dissimilar metals.

No discussion of filter design can be considered complete without some mention of the different types of filter septa.

Three general types of tubular element filters are available—porous stone, wire cloth, and wire-wound.

The porous stone tube unit is usually of bonded aluminum oxide particles, with a relatively thick wall. Such tubes have the advantage of being inexpensive and corrosion-resistant. They have the disadvantage of being easily plugged and difficult to

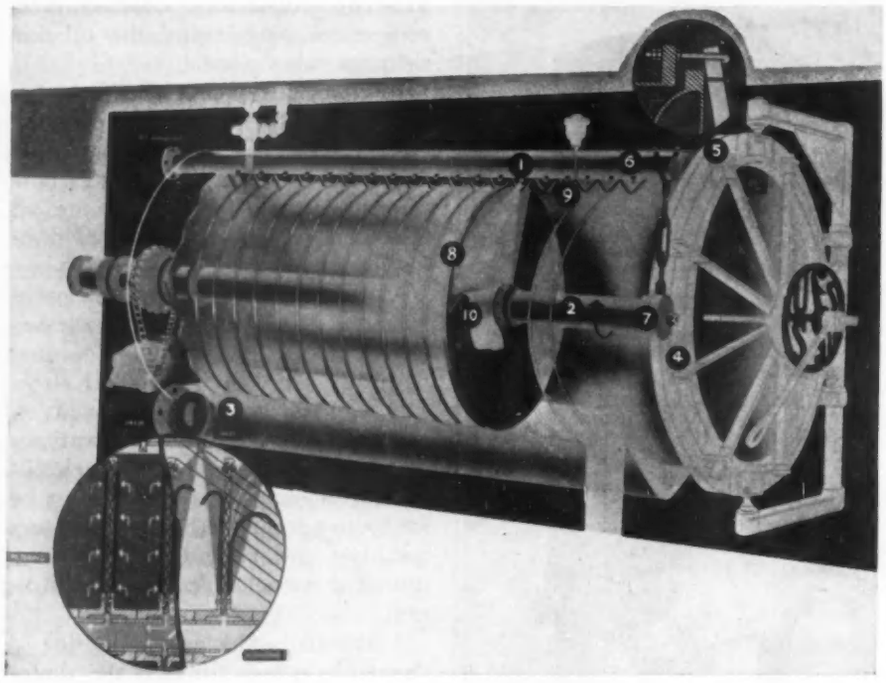

FIGURE 3—A diatomite cake is formed on each leaf for filtering in this leaf type filter generally used for oil field service. At the end of each cycle a jet nozzle knocks off the accumulated cake on the filter screen. Components of the filter include: (1) sluice-jets; (2) rotating shaft; (3) dual-purpose manifold; (4) door lock; (5) ring seal; (6) removable jet manifold; (7) removable front bearing; (8) five screen leaf design; (9) leaf alignment guide, and (10) asbestos pre-coat.

clean since the most severe plugging takes place in the interstices of the stone. They are also relatively fragile, and should be used only on relatively clean, easily filtered, oil-free waters.

The wire cloth filters are made by wrapping wire cloth around a rigid core. They have the advantages of being more resistant to plugging and more easily cleaned than stone elements. Without some external bindings, the cloth tends to stretch during backwashing and, in time, may form longitudinal creases. It is extremely important that the core of such tubes be rigid and strong to prevent distortion or even crushing in service.

The wire-wound tubes are made by wrapping wire in a helix around a rigid core. Wire with both circular and trapezoidal cross sections have been used. The latter are so made that the wider base of the trapezoid forms the periphery of the tube. Thus the cake forms and is held right on the surface, and there is less chance of plugging than in other designs. In addition, during backwashing, the velocity is greatest at that point where the cake is formed, thus providing more effective cleaning for a given over-all backwash rate.

Wire-wound elements have the advantages of strength, easy cleaning and resistance to plugging. Although they have the disadvantage of higher initial cost than the other types discussed, savings in maintenance and replacement during the life of the installation will usually justify their use in oil field service.

Filter septa used in the vertical flat leaf filters are either metal or synthetic filter cloths.

Metal cloth is stronger and more easily cleaned, but in large filters it is frequently difficult to stretch metal cloth tightly enough during construction to prevent development of "waves" or wrinkles on the surface during service. As pressure differential increases during a filter cycle, these "waves" have a tendency to move in or out upsetting the filter cake with consequent loss of clarity.

Synthetic fiber cloths can be made from the many different fibers available. They are corrosion-resistant, and usually less expensive than alloy metal cloths. They may require more frequent replacement.

Diatomite filters have been reported to be difficult to operate. When properly designed and installed with adequate auxiliary equipment, this report is difficult to justify.

Compared with sand filters, diatomite filters have two additional functions—precoating and body feeding. By use of multiport valves or remotely operated paired valves, the application of a precoat can be made simply and with little chance of error. Diatomite plants have been designed for complete automatic control and operation, so that operators need only keep an adequate supply of diatomite on hand.

Equipment for continuous, reliable, addition of body feed can be designed with confidence that it will perform as planned. Use of a metering pump to inject a slurry of diatomite and water is the most common method in use. Several such pumps have been specifically designed for this service, and these are recommended.

It is important that the pump suction not be located at the bottom of the slurry tank. The suction line should extend into the tank about a foot above the bottom and the end, made of a short length of pipe several sizes larger than the line itself, and should be turned down. This avoids pulling coarse or foreign matter into the pump where it may lodge in the valves and interrupt flow.

It is also important to use piping small enough and without constrictions so that the velocity will prevent any settling in the pipes.

Dry feeders are now available which, when used in conjunction with educators, can adequately handle the feeding problem for large installations.

Filter Aids Used. The primary filter aid producers offer a wide range of filter aid grades. They differ mainly in particle size distribution from fine to coarse. The finest grades provide the highest degree of clarity, and conversely, the lowest flow rate under standard conditions. The proper grade for a given application is that which provides optimum flow rate, for the degree of clarification required, or that which has the lowest rate of pressure increase in the case of constant-rate filtrations. Too often clarification has been sacrificed to obtain higher flow rates.

The filter aids most commonly used in water filtration are the medium to coarse grades. Figure 4 shows the particle size distribution for several grades offered by one manufacturer.

Medium grades are most commonly used in the trade. Such materials provide a very high degree of clarification with economical cycle lengths and optimum protection for the filter septa.

Design Criteria. During World War II, military development engineers

learned that even at extremely high flow rates, in the range of 20 gallons per square foot of filter area per minute, diatomite clarified water effectively. They also learned that such high rates resulted in extremely short cycles and hence inefficient use of filter aid.

In general, it is true that the faster the flow rate, the shorter the cycle. However, the relationship between these variables is not linear.

Bell[3] has reported on work done in the diatomite filtration of raw river water.

Results of his investigation are shown in Figures 5 and 6. Bell commented on these curves as follows:

"Figure 5 illustrates the fact that while high rates can be obtained, it is only at the expense of increased power consumption and very short cycles. As can be seen, cycle length increases disproportionately with decreased rates of flow, so that decreased power and labor costs also result from decreased rates of flow. The same pattern is seen in Figure 6 which is a group of filter cycles obtained using Type C filter aid which has about twice the permeability of Type B. The slope of these curves is almost identical with those for Type B, but the whole group of curves has been displaced down the vertical or head-loss axis. Coarser filter aids produce still more displacement down this axis. This, then, is another way to lower power and labor costs, but it must be remembered that *coarser filter aids usually result in decreased clarification and that use of a coarser filter aid may not be feasible because of this fact.*"

SIZE* (Microns)	TYPE A	TYPE B	TYPE C	TYPE D	TYPE E
>40	2.5	6.0	12.0	17.5	24.0
40-20	8.0	15.5	25.5	32.0	52.0
20-10	14.0	33.5	29.0	32.0	18.5
10-6	19.0	22.0	19.5	16.0	4.5
6-2	37.5	21.5	13.5	2.5	1.0
<2	19.0	1.5	0.5	—	—

* EQUIVALENT SPHERE SIZE BY SEDIMENTATION METHODS

FIGURE 4—Producers of primary filter aids offer a wide range of filter aid grades. Here is the approximate particle size distribution for several grades offered by one manufactuer.

Another significant point can be made from a close examination of Figure 5. Assuming a 10 psi terminal head-loss, the cycle length at 4 gsfm is 20 minutes with a total throughput of 80 gallons. By halving the flow rate to 2 gsfm, the cycle length is 80 minutes, four times as long, with a total throughput of 160 gallons, twice as much.

Many operators require long cycles because their treatment plants receive attention only once a day, or even once every two or three days. A low design flow rate is an answer to this problem. Flow rates as low as 0.2 gsfm with cycles up to a full week have been reported, but the authors believe that the minimum flow rate should be somewhat higher than this low value in order to maintain proper dispersion of the filter aid over the entire filtering surface. There is little doubt that very low design rates result in an initial investment higher than that necessary for satisfactory operation.

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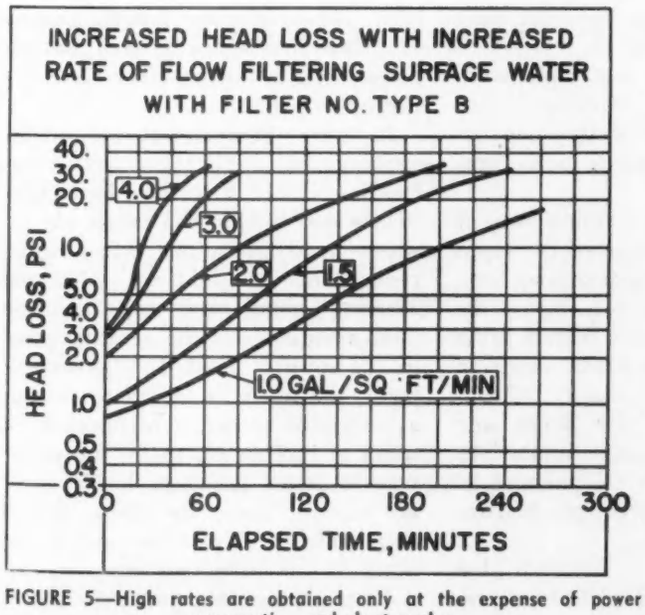


FIGURE 5—High rates are obtained only at the expense of power consumption and short cycles.

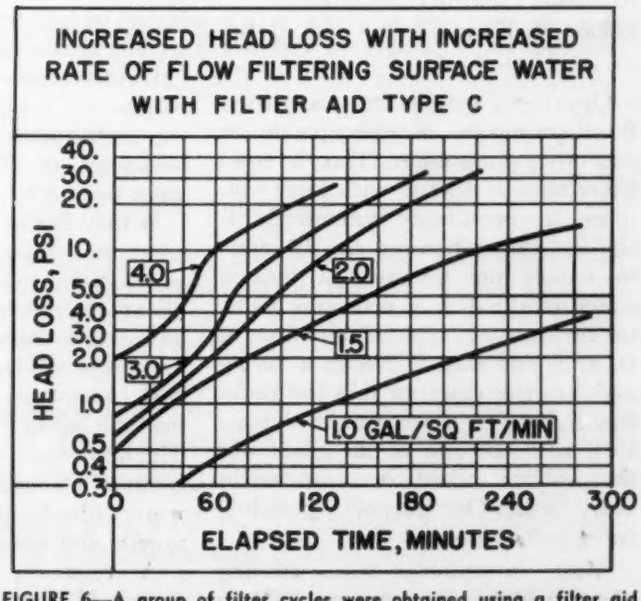


FIGURE 6—A group of filter cycles were obtained using a filter aid with about twice the permeability of those in Figure 5. Pattern is similar.

Open-type storage pond before laying asphaltic lining.

Preventing Seepage in Open-Type Ponds

The loss of flood water through seepage in open-type systems can be of vital economic importance. Prefabricated asphalt linings are proving to be an effective, new solution to the problem.

By AL GASTON
Al Gaston Construction Company
El Dorado, Kansas

OBTAINING AND treating water for a flood project is in many cases an expensive proposition. This is especially true in dealing with large volumes in open-type systems. It is obvious that whatever can be done to reduce the quantity of treated water required is of economic value to the project. The elimination of waste is one way to realize a saving and into this category falls the problem of seepage. Losses due to seepage vary with the site of the plant but the problem should be considered in every locale. One answer is prefabricated asphalt linings.

Most conventional water-treating plants will handle between 4000 to 20,000 barrels of water per day. If precautions are not taken, pollution of surface and subsurface areas will occur in the storing, treating and settling of this volume.

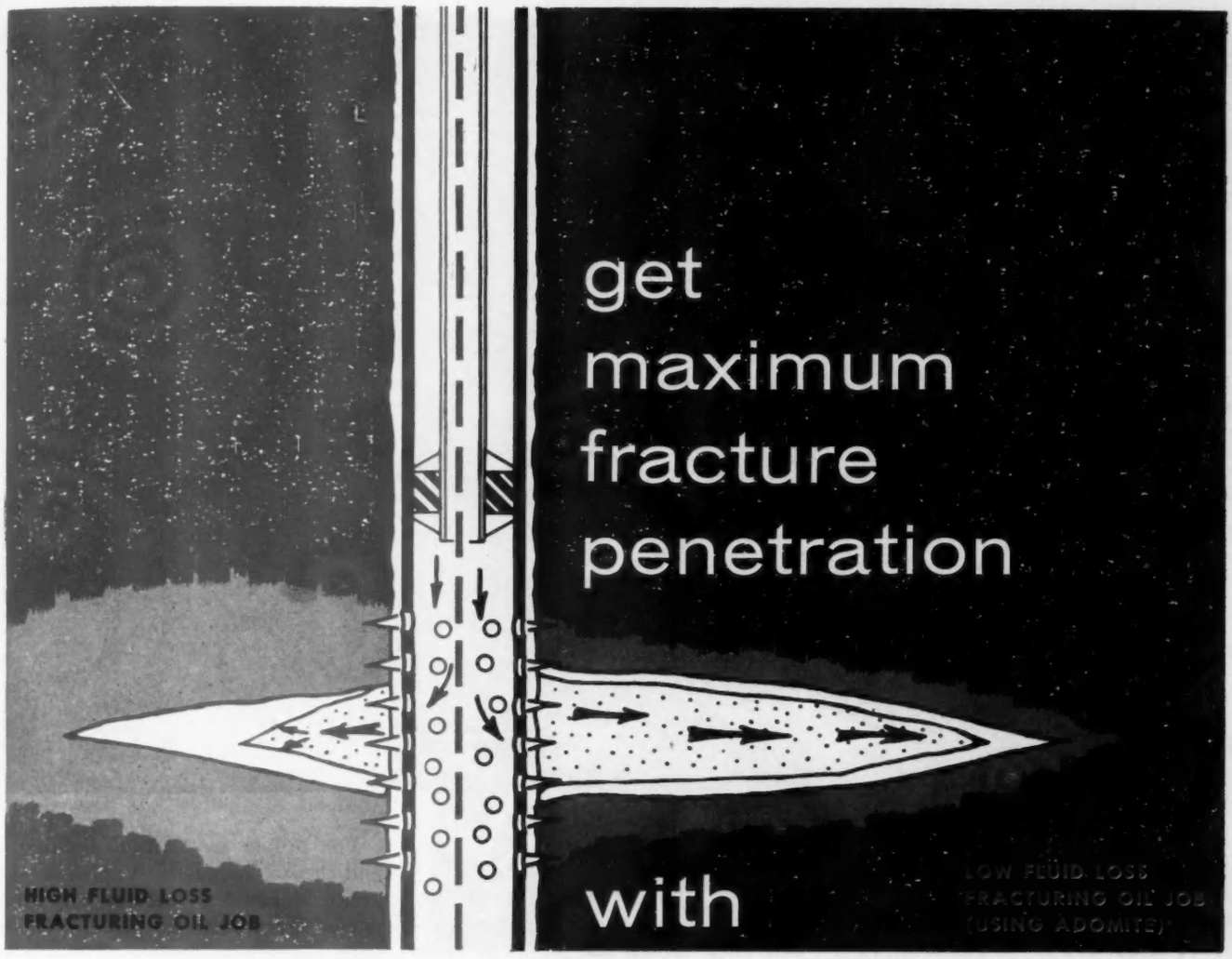
Until recently salt water pits were formed by scooping depressions into the earth, piling the earth along the perimeter of the ponds and commencing operations.

It may have been a simple way of containing a percentage of the input water, but it did present serious complications which far outweighed the advantages. Pollution of surface areas and even of water strata occurred with monotonous regularity. Cleaning the surface of the ponds and ditches was virtually impossible. Seepage claimed critical amounts of water. Finally the plant site became muddy and unsightly.

A relatively new material has proven highly successful in overcoming these problems. It is a plank-type asphalt sheet, ½-inch thick, 3 feet wide, available in lengths up to 12 feet. The customary length used is 12 feet. Sheets are factory cut to proper length, factory-coated and delivered on pallets.

In using the material and in describing its application in water-flooding, it would perhaps be helpful to review briefly the sequence of water flood operations. Most open-type plants are laid out with one aerating pond, and one aerating ditch, running from the aerating pond to the settling pond. In the settling pond, the water is forced to remain a determined number of hours by a series of baffles. Normally the water travels under the first baffle, over the second, under the third, and is then collected across the end of the pond at the water surface.

From the settling pond, the water travels to the clear water pond; from



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Seals the fracture face . . . minimizes fluid loss . . . no damage to formation.

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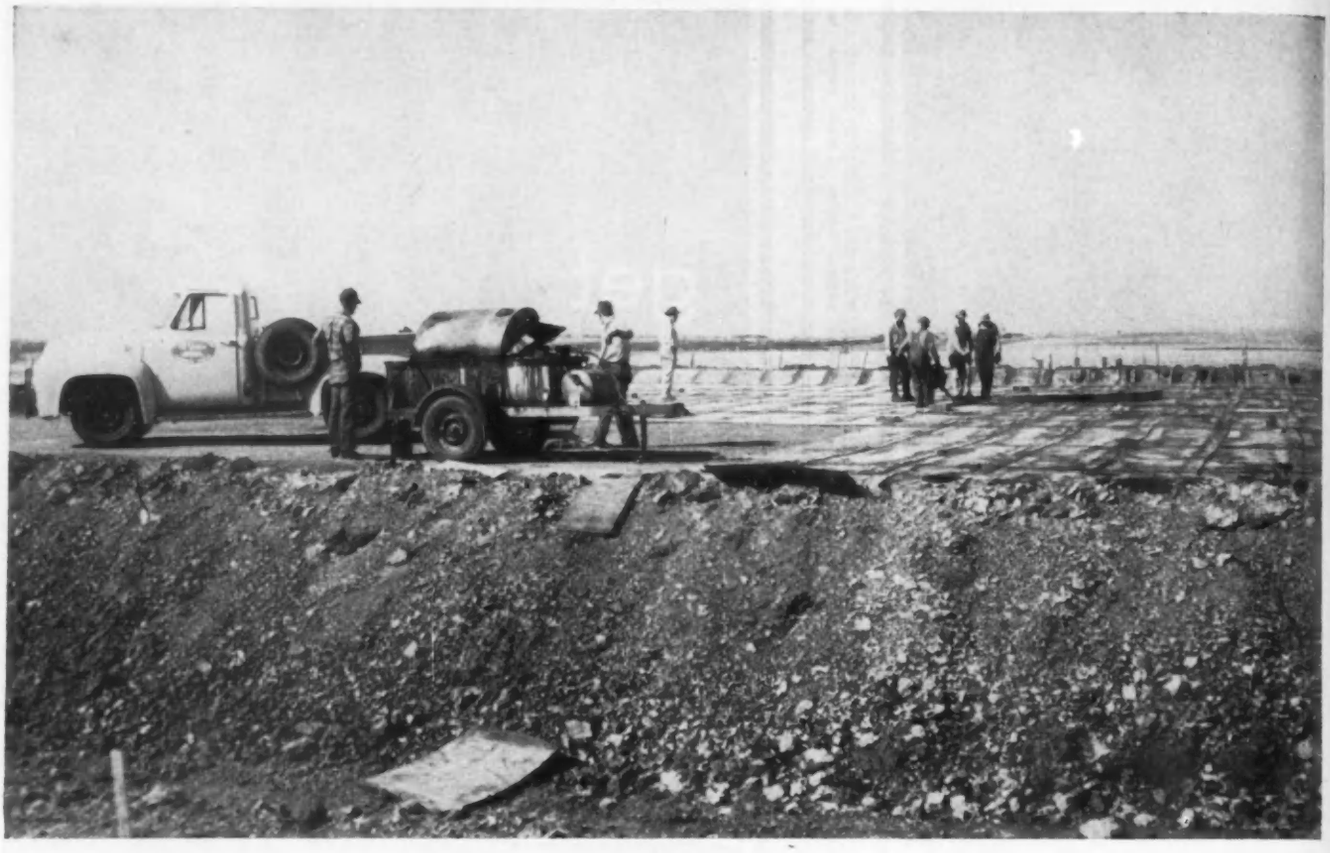
Decreases friction loss . . . low viscosity of Adomite-created fracturing fluids permits use of less pumping equipment than with viscous refinery residuals.

Reduces hazard of emulsions . . . emulsion-breaking characteristics are important consideration to many producers.

Adomite, and **only Adomite** is all you need to control fluid loss of kerosene, crudes, gelled crudes or refinery residuals.



Lining an aerating pond in a water-flood project, El Dorado, Kansas.

here it goes through filters into the clear water tank. Pressure pumps pick it up and distribute it through the water-flood system to input wells.

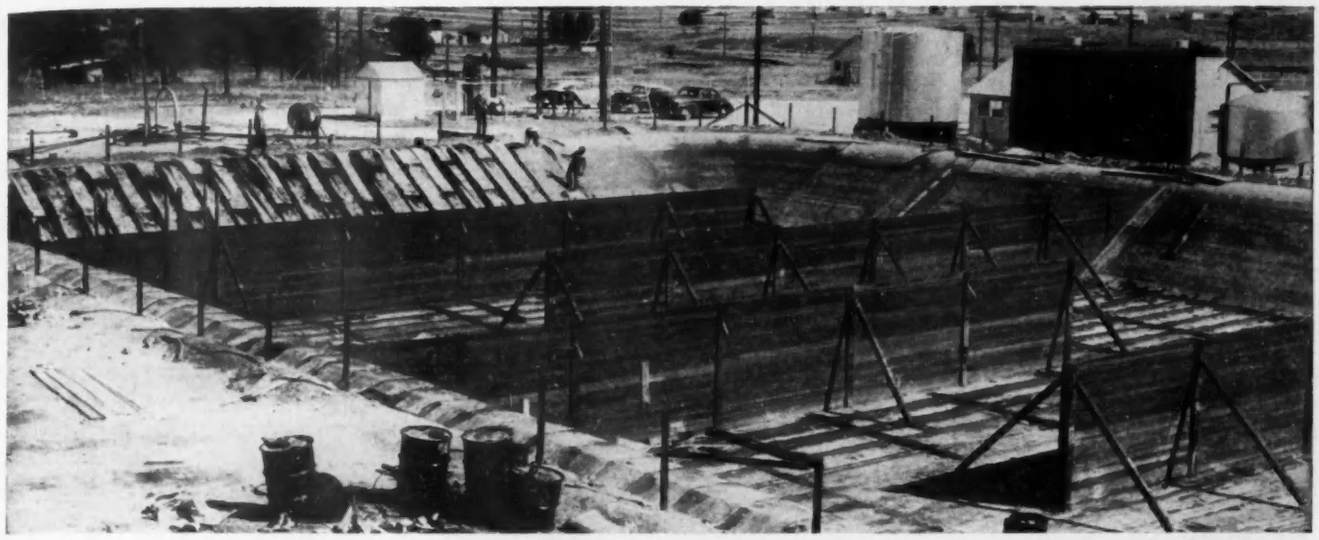
Obviously the plant presents rather large targets for pollution and seepage. However, under the new process, pollution and seepage are both permanently eliminated and at surprisingly low cost. An installation properly made should last for many years with a minimum of attention and maintenance. There is no doubt but that the material is sufficiently tough and properly designed to provide years of satisfactory service.

Lining partially completed in a fresh water storage pond at Snyder, Texas.

For proper installation, bulldozers and heavy carryalls rough-out the areas. Excavated surfaces are compacted from 90 to 95 percent, either with sheeps-foot rollers or by compaction from the heavy equipment used in construction. Slopes of all ponds should be no steeper than three to one. All large rocks and clods should be removed. A berm, 8 feet wide, is dressed out around the perimeter of the ponds. All pipes coming into the pond, whether inlet or discharge, are anchored in the berm, in concrete, to prevent them from settling.

When sheets arrive at the plant site they are cleaned along the sides and edges with power brushes. This is important since a watertight bond is easily achieved only with the edges and ends in this condition.

Sheets are placed end to end, and side by side, over floors and walls of the pond. Joints are sealed by ¼-inch thick strips, 6 inches wide, made of the same material as the sheets. A hot mop application of a special adhesive goes on the adjacent edges of the sheets, as well as to the covering strip. The strip is then "flopped," placed in position over the joint, and sealed by foot pressure. The 90-degree angle formed by the juncture of the



SUNRAY MID-CONTINENT OIL CO., TULSA, OKLA.

HAVE YOU READ THE ARTICLE ON PAGE 224?

It takes facts, figures and performance to convince Engineers. Reporters are trained to be the same way. Neither of them put a pencil to a recommendation, or to a story, until the product or service has been proved-out beyond any question.

Gulf-Seal
PREFABRICATED
ASPHALT LINING

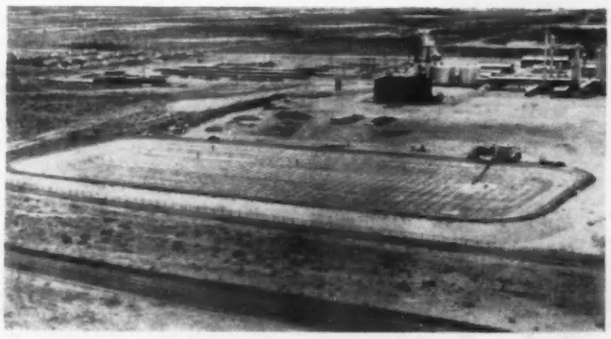
This issue of WORLD OIL carries an article headed "Preventing Seepage in Open Type Ponds," on page 224. It is written by an expert and details the success of Gulf-Seal's method of seepage-proofing salt water pits.

The method is successful because of the material —Gulf Seal Prefabricated Asphalt Linings. No amount of manipulations with inferior materials will make them work.

Put this down as a positive, proven fact: *There is no problem in salt water seepage which has not already been met and solved by use of GULF-SEAL Prefabricated Asphalt Linings.*

More than thirty leading oil and chemical companies are using this material in large quantities.

Write us, giving us some idea of *your* project. We'll be happy to help you with specific, factual, proven facts and figures. No obligation, of course.



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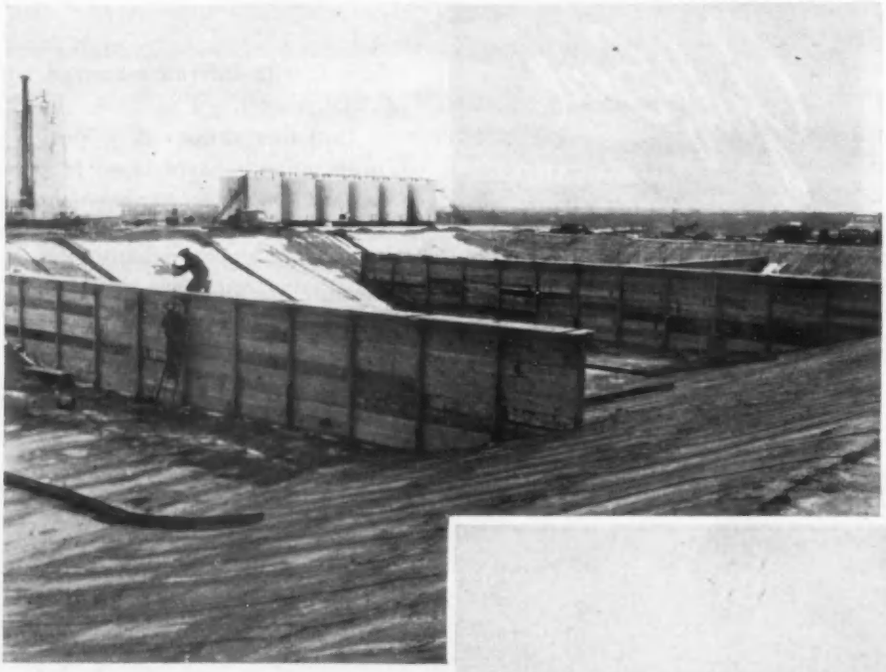
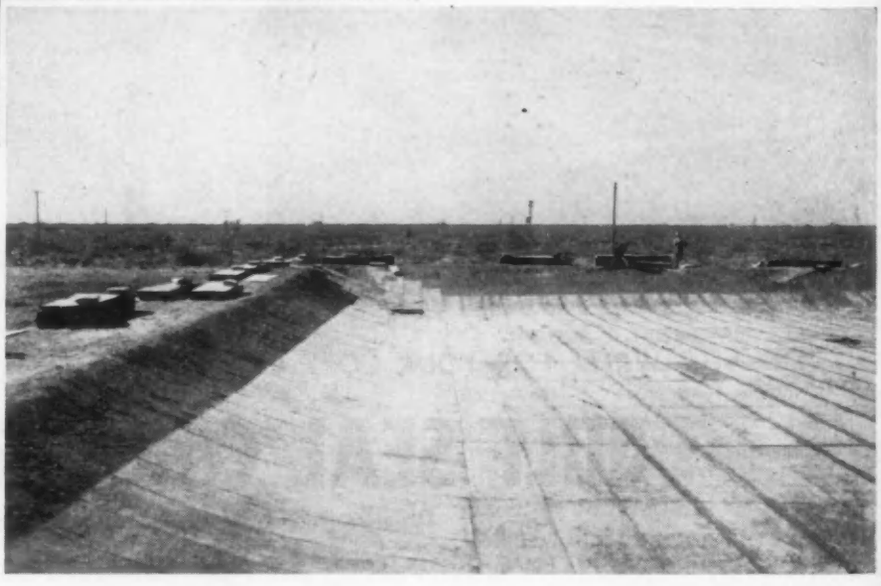
Division of Gulf States Asphalt Company

FACTORIES: SOUTH HOUSTON, TEXAS, DENVER, COLO. **EXECUTIVE OFFICES: MELROSE BUILDING, HOUSTON 2, TEXAS**

Lining pit after baffles posts have been installed.



Completing wooden baffles in a brine treating pond on a water-flood project in Greenwood County, Kansas.



Method of lining sides and bottom of a salt water storage pit in West Texas (right).

strip with the sheet is filled out with cold adhesive applied by hand.

Ditches call for a somewhat different installation. Instead of being butted, the sheets are lapped—three inches on the sides, six inches on the ends. Both lapped and lapping sheet are hot mopped; sealed by foot pressure, and then repointed with cold adhesive.

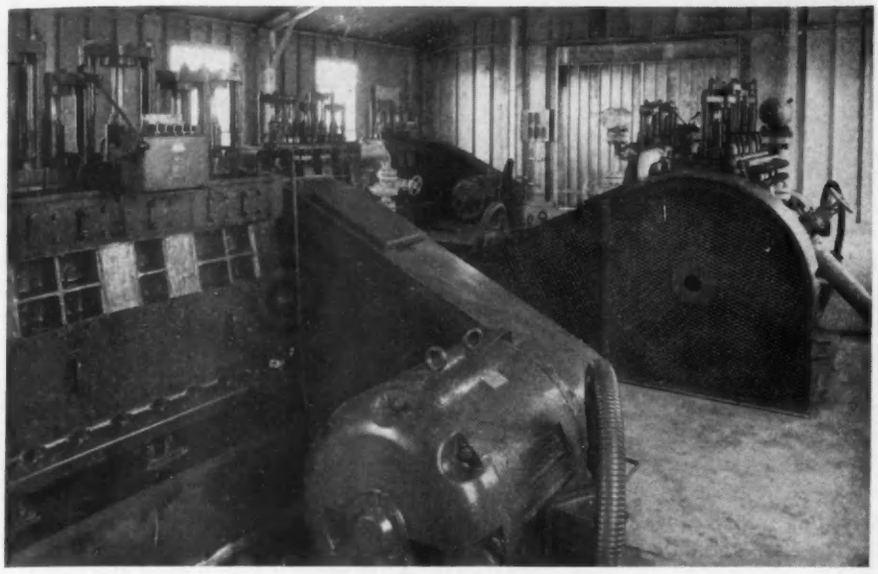
In both ponds and ditches, the material should extend over the berm and be anchored by pins into the berm. Only the outside edges are backfilled; where the sheet crosses the berm need not be covered unless severe rainfall or high winds occur frequently.

The asphalt material has a specific gravity of 1.2, which is sufficient to prevent "floating." It is strong enough to permit rubber-tired vehicles to be driven over it and cattle traffic will not cause damage.

The cost of these linings installed will average between 26 cents and 30 cents per square foot in the Mid-Continent area of Kansas, Oklahoma, Arkansas, Louisiana and Texas, depending on location and size of pond. This cost estimate has been developed out of a rather comprehensive experience in this area in actual construction of water-flood projects. It is 3 to 4 times less than the cost of monolithic structures, and usually no more than catalytic blown materials.

More than 5 million square feet of this special material is in use throughout the country. Municipal reservoirs, industrial waterways, canals, and ditches of every size have been lined with these sheets and all with uniformly high success. **—The End**

water-flood report
EQUIPMENT



Interior view of pump house on a pressure maintenance project in the Diamond M Canyon Reef Unit, Scurry County, Texas, shows quintuplex pumps in operation.

What Injection Pump Fits Your Operation?

Centrifugal and piston type surface pumps are the heart of a water-flood and should receive careful consideration when an injection system is designed.

By **GEORGE C. LOGAN,** A. M. Lockett & Co., Ltd., Dallas

PUMP SELECTION and maintenance are of prime importance in the design and operation of a water-flood and questions which often arise are:

- What types of injection pumps are available for secondary recovery operations?
- What are their relative advantages and limitations?
- How should they be maintained?

Most water injection operations in the Southwest, both pattern flooding and pressure maintenance, eventually build up to surface pressures which result in a "bottom-hole" pressure of 0.8 pounds per square inch per foot of depth. For example, the Yates formation of Ward County, Texas, is 2600 to 2800 feet subsurface, and bottom-hole injection pressures up to 2240 pounds per square inch gage may be used. With 1210 psig hydrostatic pressure in 2800 feet of tubing, pumps which are suitable for 1000 psig are generally selected. "Pressure parting" of the formation will occur at approximately 1.0 psi bottom-hole pressure per foot of depth and operators find it desirable to stay below that limit by a safe margin.

Pump Selection. A great many operators have found the multiplex plunger pump to be best suited for surface injection pressures above 500 psig. For surface pressures lower than 500 psig, the less costly duplex piston type pumps will operate satisfactorily without excessive piston packing maintenance. Centrifugal pumps are well suited for low-pressure, high-volume service and have the lowest initial cost. However, it is necessary to know precisely the pressure at which a centrifugal pump will be required to operate in order to obtain the desired volume, and it is difficult to accurately determine that pressure prior to actual start of operations. Centrifugal pumps are approximately 70 percent efficient over normal operating ranges whereas duplex piston and multiplex plunger pumps are 85 to 90 percent efficient. Therefore, economies in power consumption may be realized with the latter.

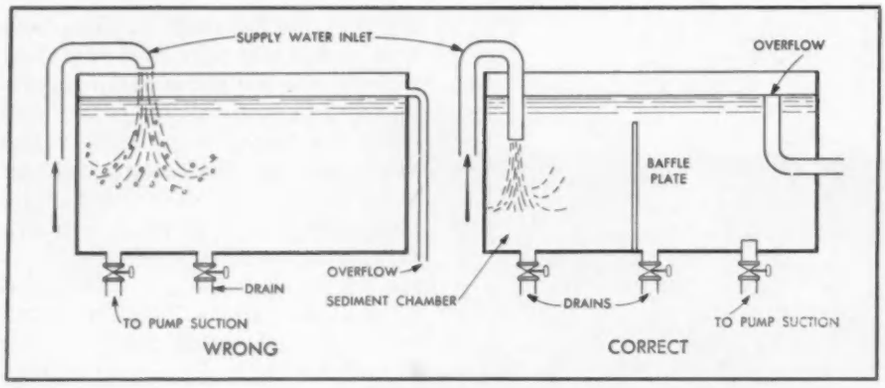
Maintenance as It Applies to Pump Selection. Maintenance of multiplex plunger pumps involves replacement of plunger packing and valve springs, and checking power end components for proper running clearances at eight to 12-month intervals; also changing crankcase oil at six month intervals.

Power end components of duplex piston pumps should similarly be checked and maintained. Piston packing will require renewal at 4 to 8 months depending on pressure, as will rod packing. Valve springs will require occasional replacement.

Assuming that corrosion is not a factor, centrifugal pumps require but very occasional inspection for sufficient bearing lubrication. Mechanical stuffing box seals have gained wide acceptance with centrifugal pumps and have eliminated the higher maintenance costs of a packed stuffing box. Impellers and impeller wearing rings should be inspected at two year intervals for wear, and replacement as appropriate.

Liquid End Materials for Piston and Plunger Power Pumps. Due to the unpredictable corrosive properties of oil field salt water, it is often desirable to select an aluminum bronze pump cylinder with aluminum bronze stuffing box and valve components and ceramic or hard faced metal plungers which will withstand wear. For multiplex plunger pumps operating at surface pressures in excess of 500 psig, forged cylinders in both steel and aluminum bronze are more reliable than castings.

Standard forged steel cylinders are suitable for mildly corrosive condi-



Suction tank arangement.

tions. Sacrificial magnesium anodes are frequently used with good success as a means of protecting a forged steel cylinder from corrosion. These are installed within the cylinder itself.

Plant Design. Piping arrangements to and from the suction storage tank are an important consideration.

For satisfactory operation of the injection pumps, sufficient head in the suction storage tank must be provided over and above the vapor pressure of water (0.5 pounds per square inch absolute at 80°F.) to satisfy the following requirements:

1. To overcome friction loss in piping to the pump. (Known as H_f).
2. To accelerate the liquid in the suction line to conform with the flow characteristics of the pump. (Known as H_a).
3. To lift pump suction valves from their seats against spring pressure and permit the plunger chamber to fill on suction stroke. (Known as *Net Positive Suction Head* required above the vapor pressure of the water being pumped, commonly abbreviated as NPSH).

The amount of storage head available above the water's vapor pressure must exceed the sum of $H_f + H_a +$ NPSH if the injection pumps are to operate properly. Pump manufacturers must be consulted as to H_a and NPSH requirements of the particular size and type of unit. Pump manufacturers should also be consulted as to size of suction header and suction piping.

Each multiplex plunger or duplex piston pump should have a relief valve in the discharge piping immediately adjacent to the pump. The discharge relief valve should relieve into the storage tank rather than into the pump suction. Manual bypassing is frequently necessary with engine or normal starting torque electric motors, when pump must start against full discharge pressure. High starting torque induction motor drivers do not require manual bypassing of the pump at start up.

Suction air chambers are standard equipment on some makes of multiplex plunger pumps; optional on others. The purpose of a suction air chamber is to reduce acceleration head requirements. Discharge pulsation dampeners are recommended, when pulsation in the discharge piping is severe.

Method of Drive. Where natural gas is available on the lease at a value of 10 cents per thousand cubic feet, gas engines may be the most desirable type of driver if gas is not sour and if there are maintenance facilities in the area which are capable of making complete engine overhauls at two to three year intervals. Oil field power units will burn 10 cubic feet of gas per horsepower per hour, the resultant cost of gas energy being .1 cents per horsepower per hour. Electric energy where available can be purchased for about .97 cents per horsepower per hour. Despite the higher cost of electric energy, however, there are offsetting advantages such as lower initial cost, very low maintenance cost, automatic operation and control, and very little loss of operating time if electric induction motors are selected as drivers.

Multi-V-belt transmission is most suitable for 170-hp quintuplex and smaller triplex pumps. For pumps larger than these, gear reducers are preferable.

Injection pumps of the multiplex plunger type are also suitable for direct coupling to single or multi-cylinder engines having speed and horsepower ratings equal to those of the pump. Adequate engine flywheels and flexible couplings must be provided in such instances.

Plunger Power Pump Maintenance Hints

1. Change crankcase oil every 3 months for an out-of-doors installation, and at 6-month intervals for indoor installation. Use a SAE 40 weight oil having rust inhibitor.
2. For optimum packing life, center the plunger in the stuffing box barrel with lower crossheads wedged against the loaded guide in their normal running position.
3. Force feed packing lubrication will increase packing life when operating pressures are 1500 psig and above. Steam cylinder oil gives excellent results as a packing lubricant.
4. Periodic inspection of the pump is recommended so that worn parts may be replaced, thus eliminating untimely and unanticipated shut downs.

Centrifugal Pump Maintenance Hints

1. Alignment must be checked after the pump has been completely piped up for the reason that pumps are easily sprung and pulled out of position by drawing up the bolts in the piping flanges where these flanges are not brought squarely together before the bolts are tightened. Piping to and from the pump must be properly supported. Pipe strains are a common cause of misalignment, hot bearings, worn couplings and vibration.
2. Arrange piping so that there are no loops in which air pockets can develop.
3. Suction piping should be one size larger than the suction opening of the pump.
4. Be sure that the bearings have the proper amount of lubrication. Too much or insufficient lubrication will cause bearings to run hot.
5. Stuffing box water seals must be provided, using cold clear water at 15 to 40 psig where there is a suction lift. Otherwise air will enter the pump casing through the stuffing box. Water seals are also desirable where the fluid being handled is muddy, sandy or gritty.

—**The End**

This is the Rio Abacaxis 1 wildcat which had reached 5085 feet in another test of the Nova Olinda area in the Amazon basin.

Nova Olinda—one year after discovery

2 Rigs, Exploration Parties Active in Remote Amazon

While Rio Abacaxis 1125 miles south of discovery well, drills ahead, Brazil evaluates its oil industry and Petrobras efforts.

By H. T. BRUNDAGE, WORLD OIL Staff

A YEAR AFTER the oil discovery at remote Nova Olinda, 50 miles up the Madeira river from its junction with the Amazon river in Brazil, two rigs were working in the area. Two seismic parties were active and were to be joined in mid-1956 by two more for Amazon basin exploration work. Plans of Petrobras (the Brazilian government oil agency) called for sending six surface geological parties into the region. In addition, one gravity crew already was working.

Essentially, though, what oil may be there was still in the ground, not in the tanks. Initially, the discovery well was completed for 200 barrels of 42.8 gravity oil daily from the interval 8,924-9,006 feet in Devonian, with 2½-inch tubing run inside 5½-inch casing and a bottom hole pressure of 1650 pounds flowing. Bottom hole temperature was reported at 176°F. A good cement job of the production string never was achieved, and considerable water accompanied early production. It soon became apparent that the well, if produced, likely would have to be pumped, no simple task at 9000 feet.

Now it is evident that the discovery well probably will have to be junked.

Wildcatting in the Amazon basin, established by Nova Olinda 1 as a prospective area, continues, with the drilling of Rio Abacaxis 1, located 125 miles south of Nova Olinda. Early in 1956 this test had reached 5100 feet in Pennsylvanian beds, and Petrobras officials expected the equivalent of the Devonian beds productive at Nova Olinda, if present at Rio Abacaxis, to be found at 6100 feet or slightly shallower.

If the pressure in Devonian beds is subnormal in this region, as the bottom hole pressure recorded at Nova Olinda suggests, it would seem expedient to prospect for such production where the Devonian is shallower. The Nova Olinda discovery well was drilled to 9058 feet without reaching basement. After the well was completed, Petrobras officials estimated that basement might be reached at about 10,000 to 10,300 feet at Nova Olinda, but such estimates are highly conjectural in such a sparsely-known area.

The majority of South American production is from sediments of Cretaceous age or younger. Comparison of Nova Olinda with Devonian production being developed by Glenn McCarthy at Los Monos in Bolivia, 1300 miles south and 300 miles west of Nova Olinda, may be meaningless. However, Devonian sands at Los Monos were estimated by McCarthy to have a potential primary yield of only about 200 barrels per acre foot, with a 50 percent increase possible with secondary recovery. Results so far at Nova Olinda are not too encouraging, but judgment of the value of the discovery is no doubt premature at present.

The Nova Olinda discovery was drilled on a seismograph prospect implemented by some surface geological data.

Market-wise, the remoteness of the area is mitigated considerably by the fact that oceangoing tankers can tie up at the Nova Olinda well and transport crude directly to any one of several Brazilian refineries. Brazil's consumption exceeds both its crude production and refining capacity, and

Continued on Page 252

REPORT ON RUSSIA . . . by Dr. J. Brian Eby

Some of the leading U.S.S.R. oil scientists. Left to right: Dr. F. A. Alexeev, gamma ray logging specialist; Dr. S. F. Fedorov, oil geologist; Dr. H. Titkov, director of the Petroleum Institute of the Academy of Science; Dr. Ulyanov, geologist; Dr. M. F. Mirchink, chief geologist in the Ministry of Oil; Dr. N. Kalinin, salt dome specialist; and Dr. Sarkisyan, geologist. Picture taken by the author, Dr. J. Brian Eby, who is reflected in the mirror in the Presidium at the Academy of Science.

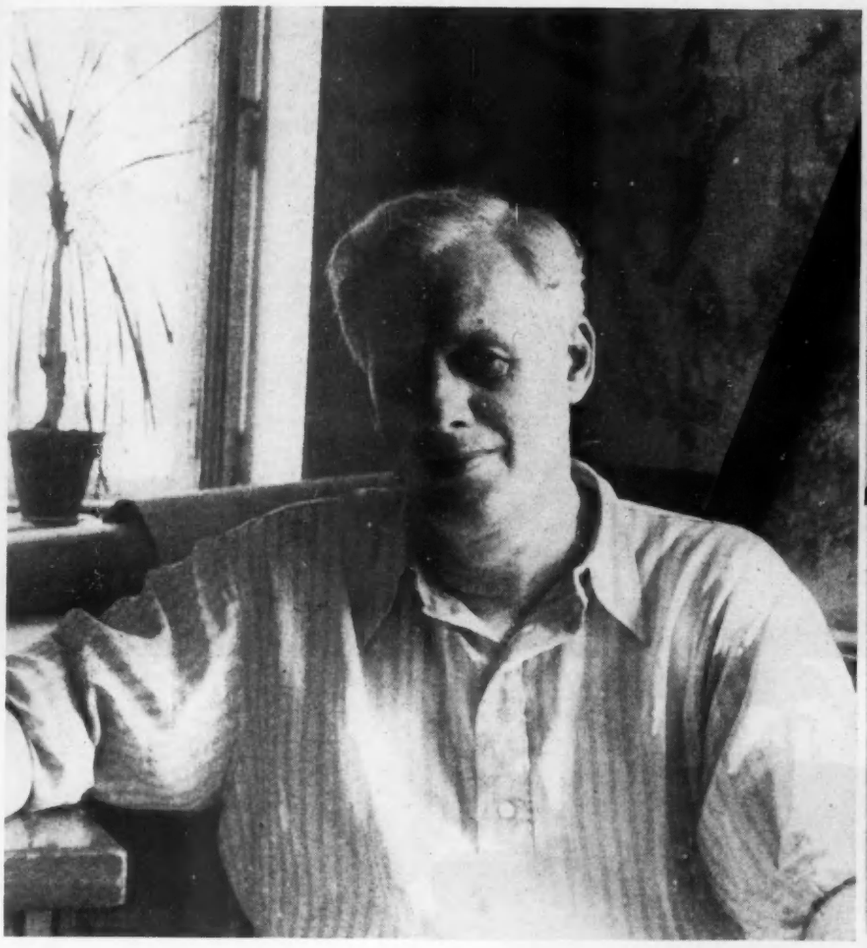
Russian Government Is Giving No. 1 Priority to Education

Soviet Union is pouring large sums of money into new facilities and is giving top salaries to leading scientists and educators. Petroleum geology and engineering are high on the list.

EDUCATION IN the Soviet Union is receiving top priority from the government. Not only are huge sums of money being poured into new education facilities, such as the vast and costly establishment of the new Moscow State University, but also salaries to top scientists and educators greatly exceed that of their counterparts in other countries.

Petroleum geology, general geology, petroleum engineering, and kindred subjects enjoy a high rank in the expanding scientific educational systems.

There are 2500 students of geology at Moscow State University and the Faculty of Geology is divided into ten chairs. Lecture rooms are designed for 30 students in the earlier years and 15 students in the later years



Professor Alexi Bogdanov, head of historical geology at Moscow State University, and who will head group of USSR geologists that will attend the International Geological Congress in Mexico City in September.

Dr. J. Brian Eby

This is one of a series of articles written by Dr. J. Brian Eby, internationally known geologist of Houston, Texas, during his recent trip to Russia as a special editorial representative of WORLD OIL.

The first of Dr. Eby's articles on the Russian oil industry appeared in the August 15 International Outlook Issue.

of the undergraduate grades. Doctorate students may work either individually or in small groups. Some special lectures may be addressed to 200-400 students.

The college education of a petroleum technologist or engineer consists of a five-year course at the University of Moscow with special training at the Petroleum Institute. There are numerous laboratories for practical training and research. These include special equipment for testing cores for permeability, porosity, fluorescence, and many other physical and chemical properties. There were about 300 petroleum engineers graduated in the 1955-56 school term. Final examinations for the term were held in June.

The Soviets are particularly interested in providing educational facilities for foreigners. According to Professor Stoletov, deputy minister of Higher Education of the USSR, there are about 14,000 foreign students in the various schools of the USSR. They come from China to Iceland and about 3500 from India, Burma, Afghanistan, Pakistan, Thailand, Ceylon, Nepal, Laos, Cambodia, Malay, and other countries.

Many will attend in the cities of Kiev, Leningrad, Dnepropetrovsk, Odessa, Kharkov, and Sverdlovsk but the majority will visit the Moscow schools. The largest number will study at the Moscow State University, but others will attend The Moscow Bauman Higher Technical School, the Moscow Institute of Power Engineering, the Timiryazev Agricultural Academy, the Moscow Motors and Highways Institute, and the Moscow Institute of Railway Engineering. These students will be provided dormitory facilities and a cash scholarship on the identical basis of native students.

In the scheme of Soviet education much, if not all, depends on individual ability and aptitude. Children enter grade schools at seven years and graduate in ten years at age 17. Entrance to the university is then selected strictly on the basis of competitive examination. Any person, whether citizen or foreigner, may try for entrance and may be admitted.

Five years of college education will be followed, if a doctor's degree is desired, by three years of mandatory outside work, in the chosen field. At the completion of three years' work the student then is subject to invitation to return for his doctorate. He cannot return to the university without invitation.

The returning student, however, faces three more years of schooling and thesis work and can obtain the doctorate after that, although the minimum time of three years is seldom accomplished. The title of Doctor outranks the title of Professor. A professor does not require the doctorate degree.

The Soviet recently issued a decree abandoning entirely the principle of tuition, and all students now are

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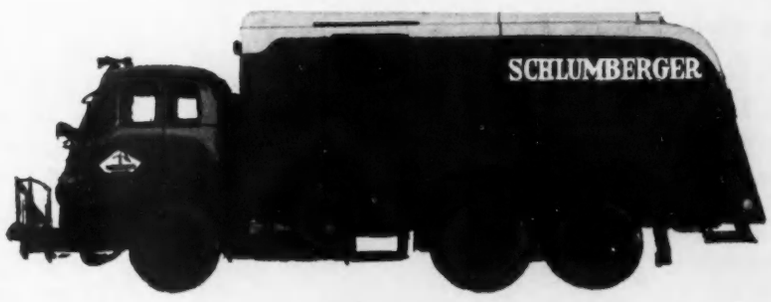

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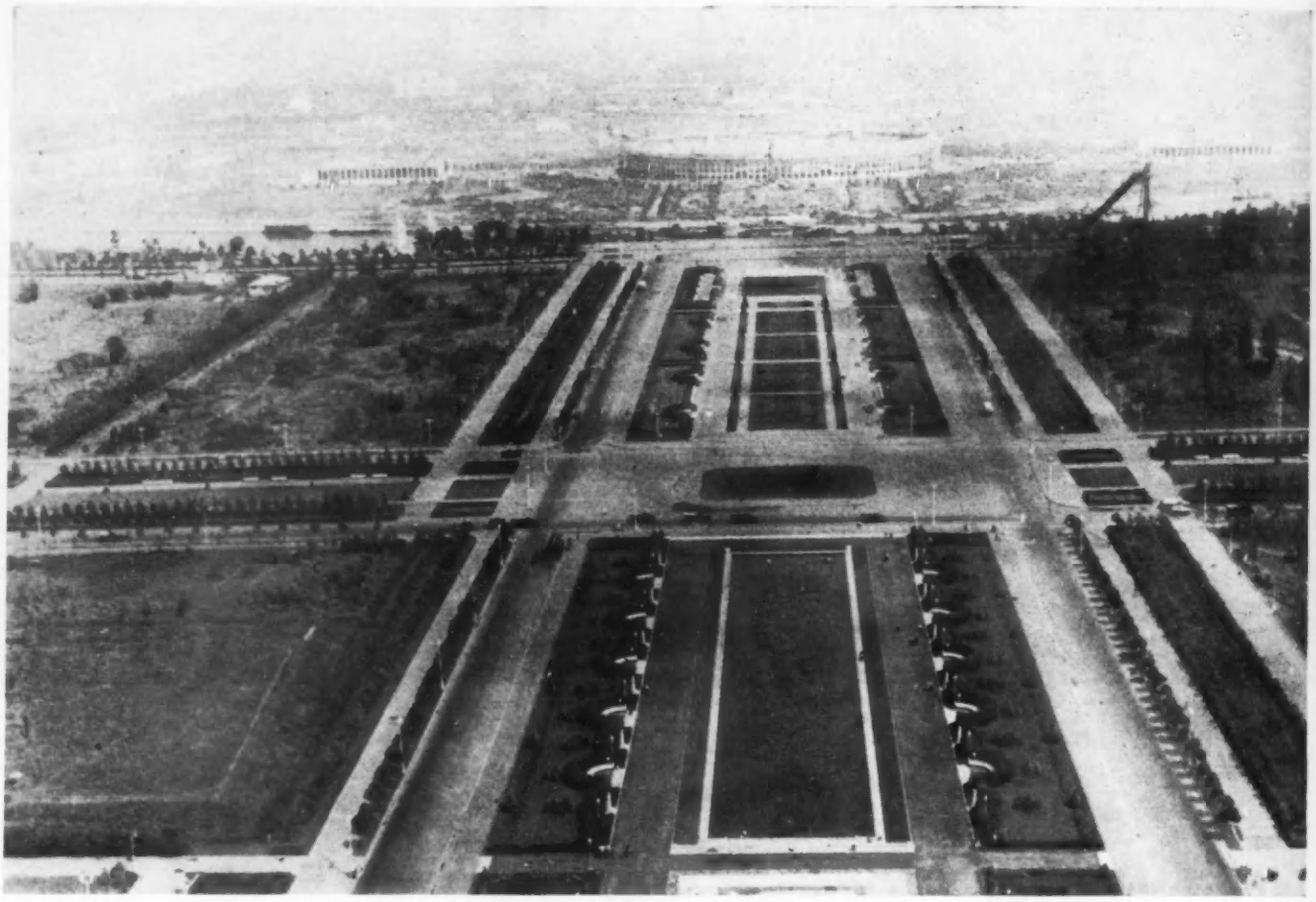


View from the twenty-eighth floor of Moscow State University, showing approach, with sports arena for 100,000 people in background across Moscow River. City of Moscow in far background.

Dr. Professor Ignatii Osipovich Brod, head of the chair of geochemistry, and his scientific secretary, Mrs. Tatiana Alexandrovna Ossipova, show the author some of the buildings at Moscow State University.

paid 250 to 400 rubles* per month to attend. Out of this they pay for meals and lodging on an extremely lenient basis.

The new buildings of the University of Moscow, founded by Peter I in 1724, are located on the Lenin Hills, west of and overlooking the city. They were planned, designed and built on a grand and modern scale. The central building is 32 stories high, contains over 1000 class rooms and laboratories and 105 acres of working floor space, and to visit each room would require a journey of 90 miles. Besides class rooms and laboratories, the main building contains an assembly hall, administrative offices, swimming pool, print shop, and numerous dining rooms.

The interior is furnished in colored marbles and the exterior hard buff building stone. The wings of the building house more than 6000 students each with separate room, completely furnished including red carpet, and one bath for two rooms.

The new building outside the city was authorized in 1948 and completed in 1953. It was the first of a series of eight proposed skyscrapers to be built in Moscow. Seven such buildings actually were built, according to the 1951-60 "general plan for the reconstruction of Moscow," but the costs were so great the eighth was never built and probably will not be. In fact so vast and wasteful of space are the grand halls and lobbies of the

* Present rate of exchange is 4 rubles = $1 U. S. Actual value, however, in purchasing power is about 10-14 rubles to $1 U. S.

new university that after completion of the building, the architect was publicly reprimanded by the government.

Education of the total of 22,000 students is carried out by a staff of 2000 professors, 20 of whom are members of the Academy of Science of the Soviet Union. There are 12 faculties and 180 chairs. Chief of the Foreign Department is Boris Nikiforob (docent), a candidate himself for a post-graduate degree. The title of docent is granted to such a student prior to his receiving the doctorate.

The geological faculty at the university is headed by Doctor Professor Eugene Sergeev, who is the head of the department. Professor Alexi Bogdanov, heads the staff of historical geology and is picked to head several of the Geological Faculty to the twentieth International Geological Congress in Mexico City, September 5 to 11, this year. Dr. Professor D. Sherbakov, member of and connected with the Academy of Science, will head the delegation from that body to the Congress.

The Presidium of the Academy of Science, located about one mile from the Moscow State University, is the headquarters of the Academy, and quarters the scientific heads of nearly all the great branches of scientific endeavor both technical and commercial application. Dr. M. F. Amiraslanov, corresponding member of the Academy, is deputy to Scherbakov and represents the Academy in the oil and gas sciences before the Technical Division of the Ministry of Oil Industry.

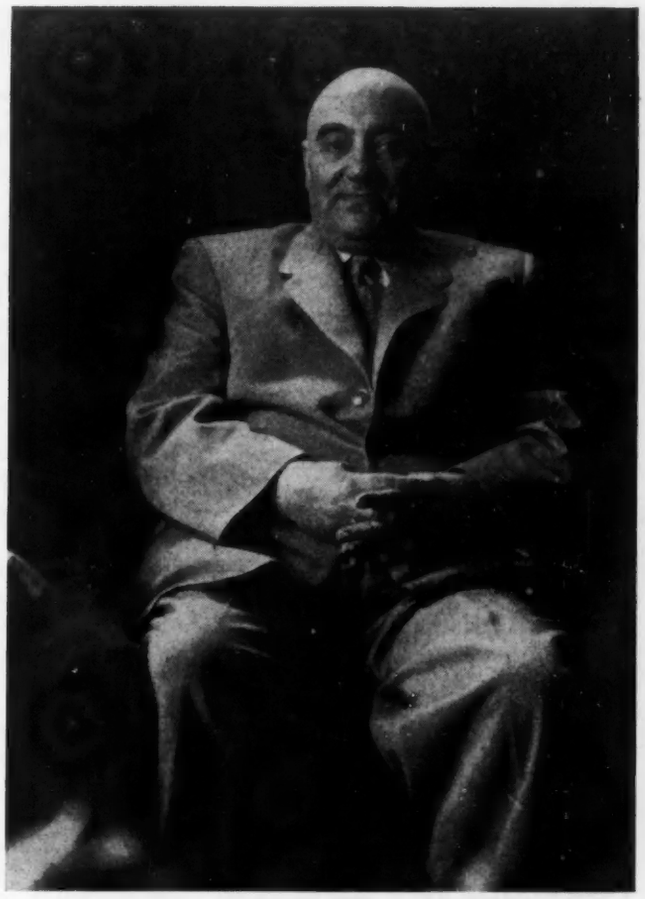
The Petroleum Institute of the Academy of Science is directed by Dr. H. Titkov and Dr. M. F. Mirchink is chief geologist in the Ministry of Oil Industry. Associated with this group are Doctors S. F. Fedorov, oil geologist; F. A. Alexeev, radio active logging; Dr. N. Kalinin, salt dome specialist; Sokolov, geochemist, and Ulyanov and Sarkisyan, technicians.

The Geological Department at the university, which occupies some space in each of floors 21 to 28, contains five separate museums, each about 5400 square feet and one to a floor, starting on the 28th or uppermost floor, with models, charts, and paintings in all matters pertaining to the origin of the earth. The next lower museum contains an exceedingly fine collection of rocks and minerals. Progressively, the museums display types of fossils throughout the various geologic ages, and many other phases of geography and geology. Many of the exhibits come from the various branches of the Academy of Science, the Institute of Oceanography and similar organizations of scientific research in the Soviet Union.

Of especial interest to Americans is a new depth map of the Pacific Ocean, not yet issued but displayed in unlettered proof based on surveys made in 1954. It reveals a great trench parallel to and near the Kurile Islands reaching a maximum depth of 34,029 feet, the second greatest oceanic depth in the Pacific.

Curator V. A. Aprodov, of the Earth Origin Museum, and Curator Micheal Kapitonow, of the Mineral Museum, were proud of their displays and with good reason. Aprodov expressed his greatest personal admiration for the late Professor Waldeman Lindgren, famous American geologist and mineralogist of the past generation.

Under the Russian educational system, the professors and faculty themselves are not beyond reach of the selective system. Every five years, the head of a chair may call for his entire faculty to take competitive examinations to determine whether changes or eliminations should be made.



Dr. A. A. Amiraslanov, corresponding member of the Academy of Science, and deputy to Dr. Sherbakov, member of the Academy of Science.

The Academy of Science of the USSR represents the ultimate goal of the scientist. Membership is limited to 100 persons living in the Soviet Union. Every three years, if one or more vacancies occur, in the interval, the date for selection is advertised in the newspapers throughout the Union and anyone, with or without a degree of science, may apply. Selection is then made by the members of the Academy.

The University of Leningrad, located on the banks of the Neva river in the city of Leningrad, is organized along identical lines as the Moscow University. It has approximately 12,500 students and has an excellent geological department supported by a fair-sized museum.

The geological department is headed by Academy members, D. V. Nalivkin, assisted by Professors A. A. Polkanov, petrography, and D. L. Stepanov, paleontology. The following specialists also are on the geological faculty:

Prof. V. F. Pchelinzev, Pelecypods, Gastropods, Cretaceous and Tertiary; Prof. T. Korobkov, Pelecypods, etc., Triassic; Dr. Sokolov, Coelenterates, Permian; Docent, D. Bodilevski, Ammonites, belemnites; Docent, A. Touroutarov, Paleobotany.

Dr. Professor Sergei Kusnetsov, curator of the museum, is the author of a recent monograph on gastropods from the Caucasus region. **—The End**

What's Happening

AMONG WORLD OIL MEN

ARNOLD LARSEN, treasurer and assistant to the executive vice president, Husky Oil & Refining, Ltd., Calgary, Alta., Canada, has been appointed vice president, finance.

Arnold Larsen

Husky's directors also announce the appointment of W. E. POWELL, formerly vice president, land and exploration, to the post of vice president, exploration and production.

•

C. C. BIMEL, who has managed Imperial Oil Limited's crude oil purchasing division at Calgary, Alta., Canada, since 1951, will move to Havana, Cuba, to become manager of the Supply and Transportation department of Esso Standard Oil, S. A.

•

W. W. POWELL has been appointed British American Oil Company, Limited, zone production manager at Regina, Sask., responsible for production operations in Saskatchewan and Manitoba. The following personnel, in their new positions, also will be headquartered in Regina.

R. F. GILMOUR, zone engineer; A. JANISCH, zone reservoir engineer; N. LUDWICK, zone mechanical engineer; H. J. STRAIN, zone drilling engineer; and A. F. DUFFNER, zone clerk.

M. J. MELNYK has been appointed area engineer at Estevan, and H. H. ELASZ has been made area clerk at Estevan. H. H. MANNING was appointed zone exploration manager at Regina, assuming responsibility for exploration operations in Saskatchewan and Manitoba.

•

W. L. KITSMAN has been promoted to the position of district superintendent of Phillips Petroleum Company's Canadian production operations, with headquarters in Calgary, Alberta. He replaces W. S. DERRICK, who has been transferred to the Bartlesville, Okla., general headquarters of Phillips.

Prior to his promotion, Kitsman was assistant division superintendent of the company's western division, Midland, Texas. He was graduated from Michigan College of Mines in 1934. He has been with Phillips since 1936, with the exception of three years spent in the Army during World War II.

•

Following the retirement of W. E. JENKINS, C.B.E., as managing director of Esso Petroleum Co., Ltd., H. C. TETT and R. J. PINDER were appointed managing directors. C. CHILVERS, manager, Coordination and Economics department, was appointed to the board of directors.

Jenkins, who was appointed a director in 1945, first joined Esso in 1920 and was appointed secretary in 1933. After a special assignment abroad, he became comptroller and secretary in 1936. At the outbreak of World War II, he was appointed Petroleum Board Controller, Finance and Accounts, and for these services was awarded the C.B.E.

Tett joined Anglo-American Oil Company in 1928 as an assistant in the Technical Sales department, later becoming manager of the department. During World War II, he served as a member of the Technical Advisory committee of the Petroleum Board, the Aviation Supply committee, and the Inter-Services Coordination of Specifications committee. He was named managing director in 1947 of Esso Development Company, and in 1949 returned to Esso Petroleum as general sales manager. He was named to the board of directors in 1951.

Pinder, who joined the company as a clerk in 1920, has held positions in the sales organization and in 1937 was appointed executive assistant to the International Association (Petroleum Industry) Ltd. In 1945 he returned to Esso Petroleum to assist the reorganization of the Sales department. He was named deputy general sales manager in 1950 and became manager in 1951. In 1953 he was appointed to the board of directors.

Chilvers joined the Anglo-American Oil Company as a chemist in 1926 and was appointed manager of the Technical Sales department in 1939. After serving with the Petroleum Board during the war, he returned to the company and was successively manager, Costs and Operations department, and manager, Coordination and Economics department.

•

JOHN L. REDMOND, geologist in The Ohio Oil Company's Calgary, Alberta, Production district, has been transferred to the company's subsidiary in Libya, North Africa, the Oasis Oil Company of Libya.

John L. Redmond

Born in Maple Creek, Sask., Canada, Redmond received his bachelor's degree in geology at Tulsa University in 1953. While working for Ohio Oil, he has been stationed in Colorado, Nebraska, North and South Dakota, Montana, Alberta, and Saskatchewan. He is a member of the Alberta Society of Petroleum Geologists and the AAPG.

•

WILBURN T. ASKEW, formerly manager of Sun Oil Company's Marcus Hook, Penn., refinery, has been named president of Sun Oil Company, Ltd., of Canada. He succeeds JOSEPH N. PEW, JR., Sun's chairman, as president of the Canadian subsidiary.

Askew was succeeded at Marcus Hook by C. Calvin Naylor.

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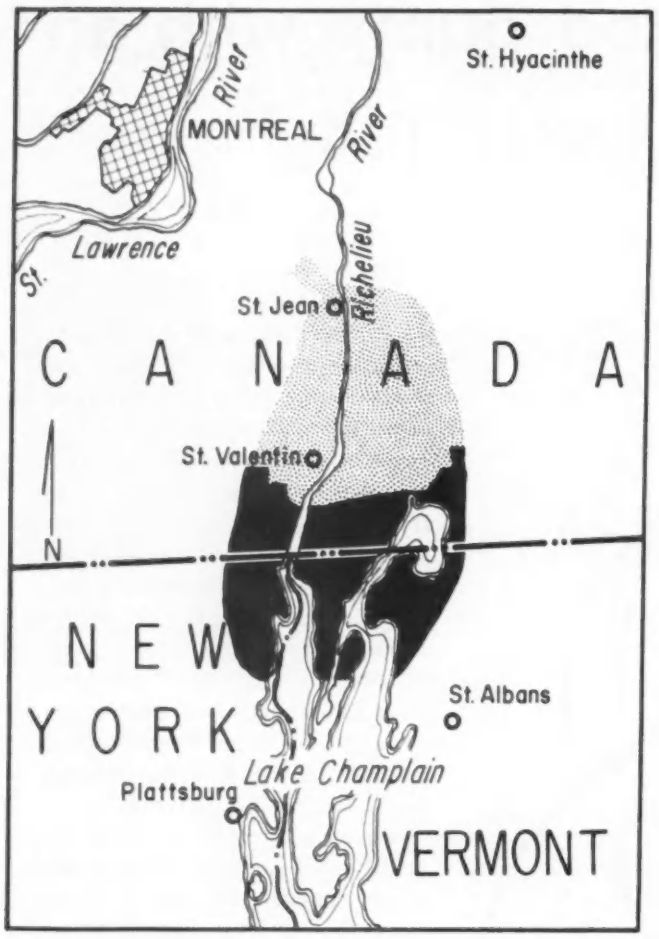

The St. Lawrence Lowlands, long known as a potential gas and oil region, is bounded by good road, rail and water facilities. This map shows the potential area, extending possibly into Vermont, expected to undergo extensive exploration.

St. Lawrence Lowlands Drawing Renewed Interest

With Canada's largest natural gas market lying in the center, this region—long a potential gas-producing area—is the object of mounting plans for exploration and drilling.

By E. FANCOTT
Montreal

A FARMER drilled a well for water near Three Rivers, east of Montreal Quebec, and struck a gas well that may write economic history along the lower reaches of the St. Lawrence Seaway. The gas tested 1,841,000 cubic feet a day from a 2-inch casing after it blew in and ran on an open flow test for 11 weeks. When it was closed by Imperial Oil Ltd. at the request of the Quebec Government, it was producing between 4 MMcf and 5 MMcf daily.

The St. Lawrence Lowlands, long known as a potential gas and oil region, has been a neglected corner of the continent from an exploration point of view. Yet it has everything that wildcatters could wish for—good road, rail and water facilities. And Canada's largest refinery and largest untouched market for natural gas lie in the center of the area.

The St. Lawrence Lowlands is a plain bordering both sides of the river of the same name. It is roughly in the form of a long triangle with a narrow apex at Quebec. The northern border extends about 200 miles from Quebec through Montreal; the base runs from Montreal south through the Vermont border to Lake Champlain—about 50 miles. The total area might be between 4000 and 5000 square miles.

Topography. The region consists of very flat farm lands that are broken into narrow lots of 126 acres, often split along the length into halves and quarters. This division resulted from the French-Canadian strip-farming principle under which farmhouses are grouped along range roads and are never very far apart. In some districts, farms are well cultivated; in others, they are left to scrub wood or pasture for a few cattle.

The entire Lowland region is well served with paved roads and no part is far from rail transport. The St. Lawrence river flows roughly from southwest to northeast and numerous tributaries flow into it from north and south. Most of the large towns of Quebec, most of the large industries and most of the Province's population are found within the Lowland basin.

Geology. According to H. R. Morris, consulting petroleum geologist of Calgary, Alberta, "The St. Lawrence Lowlands consist of a relatively flat area between the Pre-Cambrian Shield to the north and the Appalachian Mountains to the south. The Lowlands are covered with glacial drift and valley deposits of sand and silt which successfully mask the underlying Paleozoic sediments except for such outcrops as may be found along the St. Lawrence river and its tributaries. The underlying Paleozoic sediments consist of Ordovician and Cambrian shales, sandstones and carbonates. Although, in whole, the St. Lawrence Lowlands consist of a sedimentary basis, numerous faults are present, several Cretaceous or tertiary intrusives and a few small anticlines..

"The most favorable sediments for the accumulation of oil and gas are the Trenton Limestones, the Beekmantown dolomites and the Potsdam sandstones, The numerous black shales that occur throughout the Ordovician section may be classified as excellent source beds for natural gas as demonstrated by the number of water wells that have been drilled in areas underlain by these shales which have found natural gas. Numerous gas seepages in addition to the gas found in water wells are reported throughout the St. Lawrence Low-

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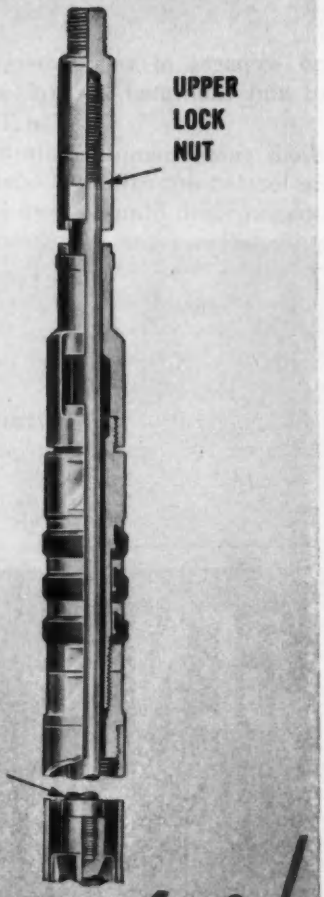

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lands, although no seepages of oil have been reported and confirmed."

Economics. Numerous small manufacturing centers are located throughout the Lowland region, and Montreal, a large manufacturing center, is a city with a population of almost 2 million. Montreal is a major port with facilities to handle the largest tankers.

It is Canada's largest refinery center, and at present is supplied by pipe line from Portland, Maine. As a market for natural gas, industrial and domestic, it offers minimum pipe line problems and the maximum price. The Trans-Canada pipe line to bring natural gas from Alberta will not be in operation for several years and, far from being a competitive factor, is a guarantee of sustained prices.

The search for adequate reservoir resources near a major market also must be considered as an added possible dividend to wildcat drillers.

History. Many farms have been using natural gas tapped from water wells for household and farm heating since 1880. Spasmodic attempts have been made to develop the natural gas commercially at roughly 20-year intervals since then. Reason for the failure of these attempts has been mainly inadequate financing and inexperience. Most of the few deep wells were drilled before the development of modern oil exploration and well completion techniques and without geological consultation. The number of deep wells drilled is not more than a few dozen, about one to every 200 square miles.

A report for the Quebec Department of Mines on the Lowland region says:

"It should be emphasized that, with hardly any exception, no deep well drilled expressly for natural gas has been located with regard to a favorable structure. Hence, the record of negative results obtained in the deep drilling is not to be wondered at and should by no means be taken as an indication of the ultimate possibilities of this region."

Current Activity. The first serious exploration of the Lowland region began with the activities of a few individuals in 1952. By 1955 interest had developed so rapidly that exploration rights for more than a million acres had been taken up or applied for. At present, efforts are being made to acquire the exploration rights for more than another million acres.

Imperial Oil is the largest holder with 600,000 acres. Eastern Canada Gas & Oil Ltd. holds 128,000 acres, Oilmont Petroleum Corporation has 140,000 acres, and Great Sweet Grass Oils Ltd. about 60,000 acres. Numerous other companies hold smaller acreages and many western Canadian oil companies are moving into the area.

Imperial Oil has completed gravity meter and seismic surveys and planned to drill three holes in 1956. Oilmont, in conjunction with Okalta Oils, has planned a geophysical survey and was planning to drill this year. Eastern Canada Gas & Oil Ltd. has drilled five test holes, two diamond drill and three cable tool, one of which was drilled to 4000 feet.

Adequate information now is available to justify the company's undertaking a full drilling program, and there is confidence that with the ap-

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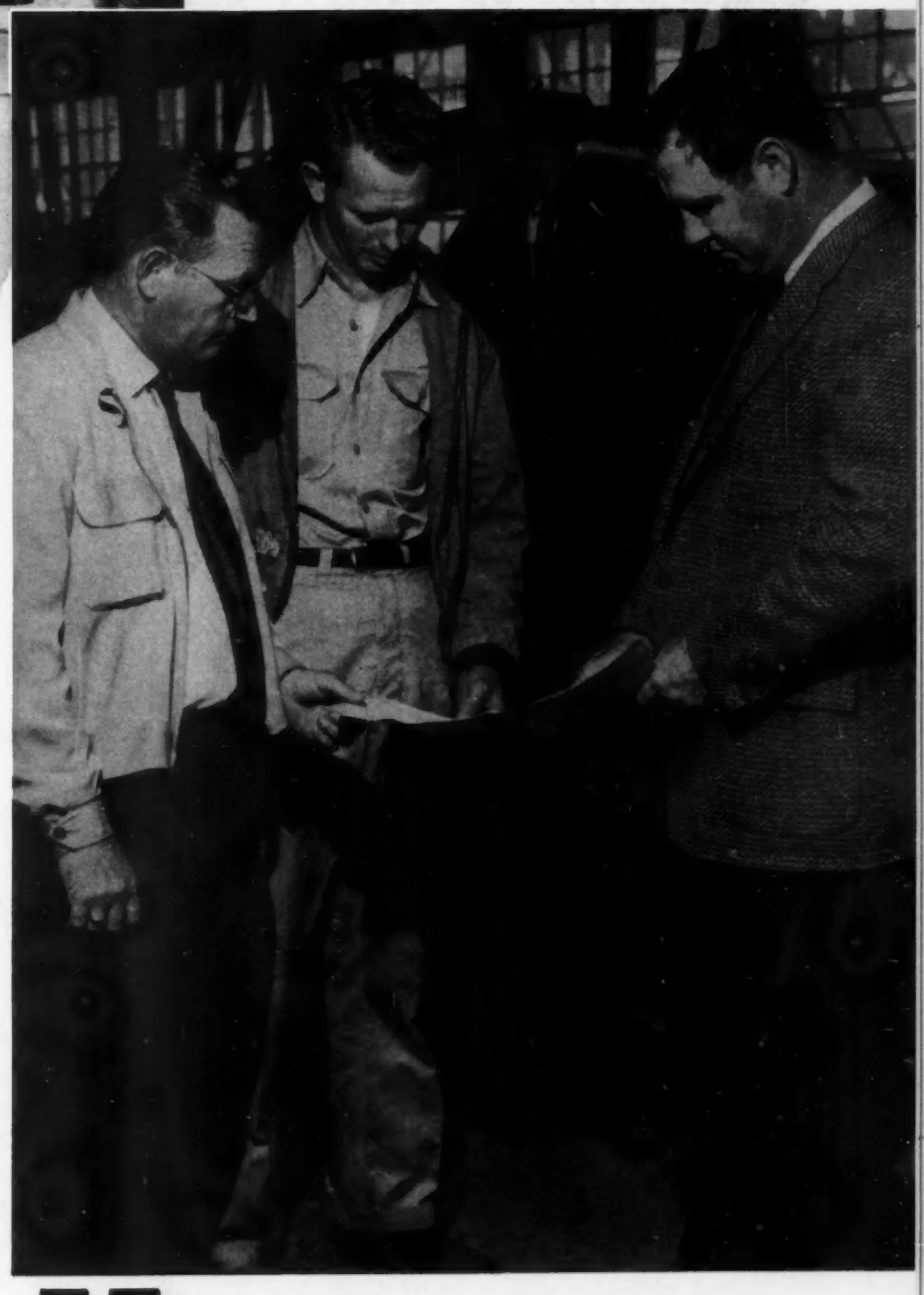

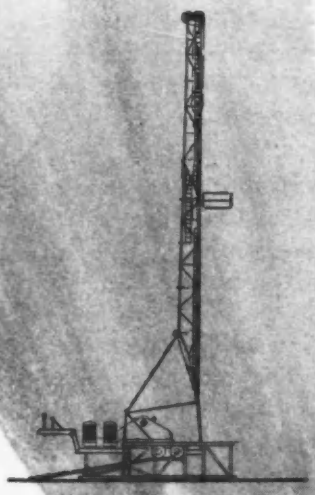

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plication of proper completion techniques the wells already drilled will be commercial producers.

Great Sweet Grass began a drilling program at the end of 1955 in the Three Rivers district. It was planned to test drill to 2500 feet. But gas blew in from 400 feet with such pressure that it was decided to plug the hole and plan a full drilling program to test the surface gas over a large area before pursuing a deep drilling program. This preliminary program will be completed in 1956, and it is hoped sufficient information is obtained to permit an evaluation of the Three Rivers district.

Ownership of Oil and Gas. The mineral rights in the Lowland region belong to the Crown (Provincial Government), and application for primary rights must be made to the Provincial Government in the request for a Mining Research Permit for exploration for oil and gas and related petroleum products.

In an interview, Jean Miquelon, Q. C. (Queen's Counsellor), who represents a number of oil companies in Quebec and is familiar with the land situation and the mineral laws of the province, said:

"The Provincial Government has appointed a commission to examine and revise the mining laws of the province, and those relating to oil and gas exploration and development are due for expansion and revision. The government is therefore exercising caution in issuing Mining Research Permits in the interest of ensuring an orderly and competent development of the oil and gas resources of the province."

Vermont. The State of Vermont is taking an active interest in the exploration north of its borders and the state geologist, Prof. Charles G. Doll of the University of Vermont, has visited the drilling operations neighboring the Vermont border. The Lowland formations run down into Vermont and Prof. Doll says it "is conceivable that there may be oil and gas in northwestern Vermont."

—**The End**

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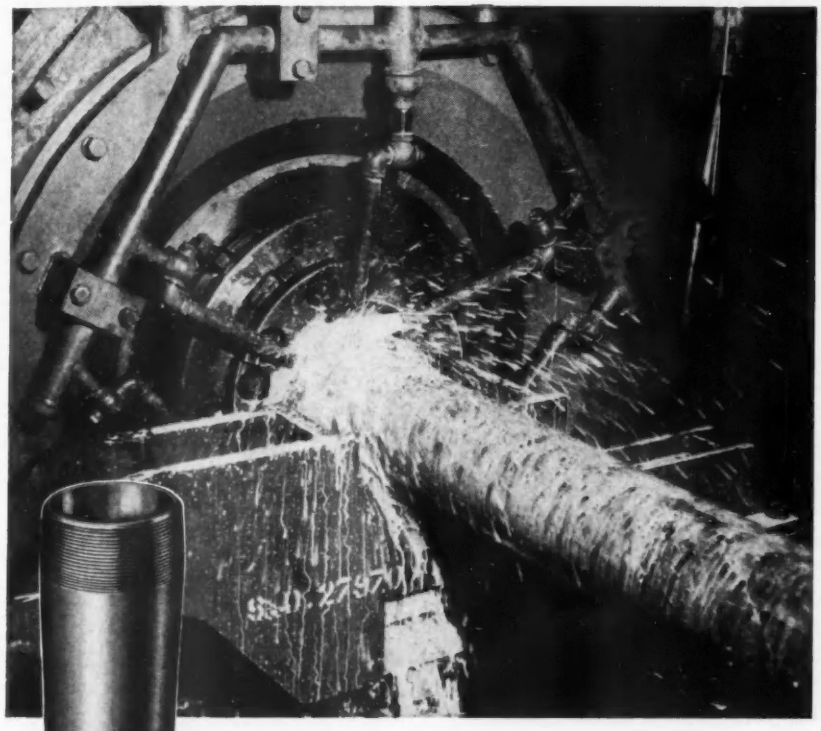

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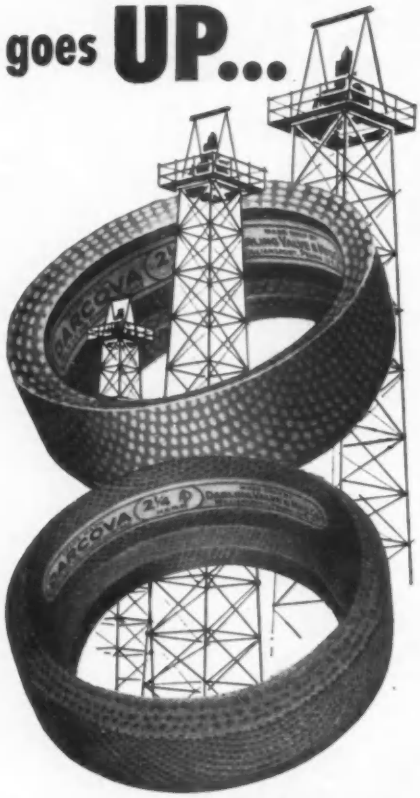

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Nova Olinda

Continued from Page 237

consumption is growing rapidly. Therefore there is pressure on Petrobras to build up domestic capacities.

The new Manaos refinery, less than 100 miles from Nova Olinda, and about 200-mile haul via the Madeira and Amazon rivers, is in final stages of construction and will have a crude charging capacity of 5000 barrels per day in 1957. However, the new refinery is committed to take crude from Ganzo Azul field in eastern Peru.

In July, 1955, Colonel Artur Levy, then president of Petrobras, before a Brazilian Lower House Commission created to investigate the petroleum situation, testified that the Manaos refinery had contracts for Peruvian oil and the commitment should be honored. He added that Nova Olinda crude could be transported to other Brazilian refineries.

Other testimony during the same hearing cited Petrobras' active efforts to build up its refining capacity, both through expansion of current facilities and new refinery construction. Other officials pointed out Brazil's effort to consolidate and expand its tanker fleet, and cited its growth from zero in 1938 to 223,000 tons carrying capacity in 1955, tenth in the world.

This hearing indicated what Brazilian geologists expect of the Amazon region. Colonel Levy said that beds in the Amazon basin have little dip; that there are large anticlines, constantly repeated. "Nova Olinda, Rio Abacaxis, and Trompetas are all structures where wells will be drilled . . . diabase occurs in Amazonas but it is not continuous, so results can be obtained from geophysics . . ."

Further testimony indicated that geophysical data were confused by what originally was taken as basement at only 2300 feet but reinterpreted by Petrobras geologists. A bed of salt 1000 feet thick was topped at 2300 feet at Nova Olinda 1. This zone is expected to have a corrosive effect on drill pipe and casing. There was considerable controversy as to the wisdom of moving a rig, capable of drilling to 10,000 feet, away from the thick sedimentary basin at the Amazon mouth, where several deep holes were drilled without finding any oil but which indicated a promising, thick sedimentary section. —**The End**

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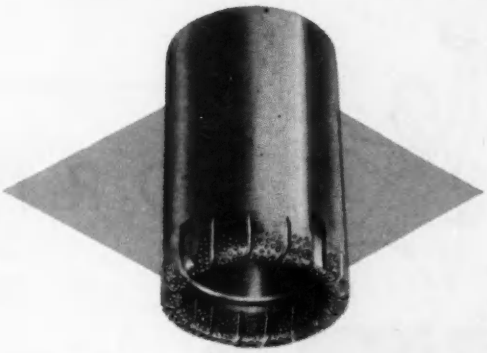

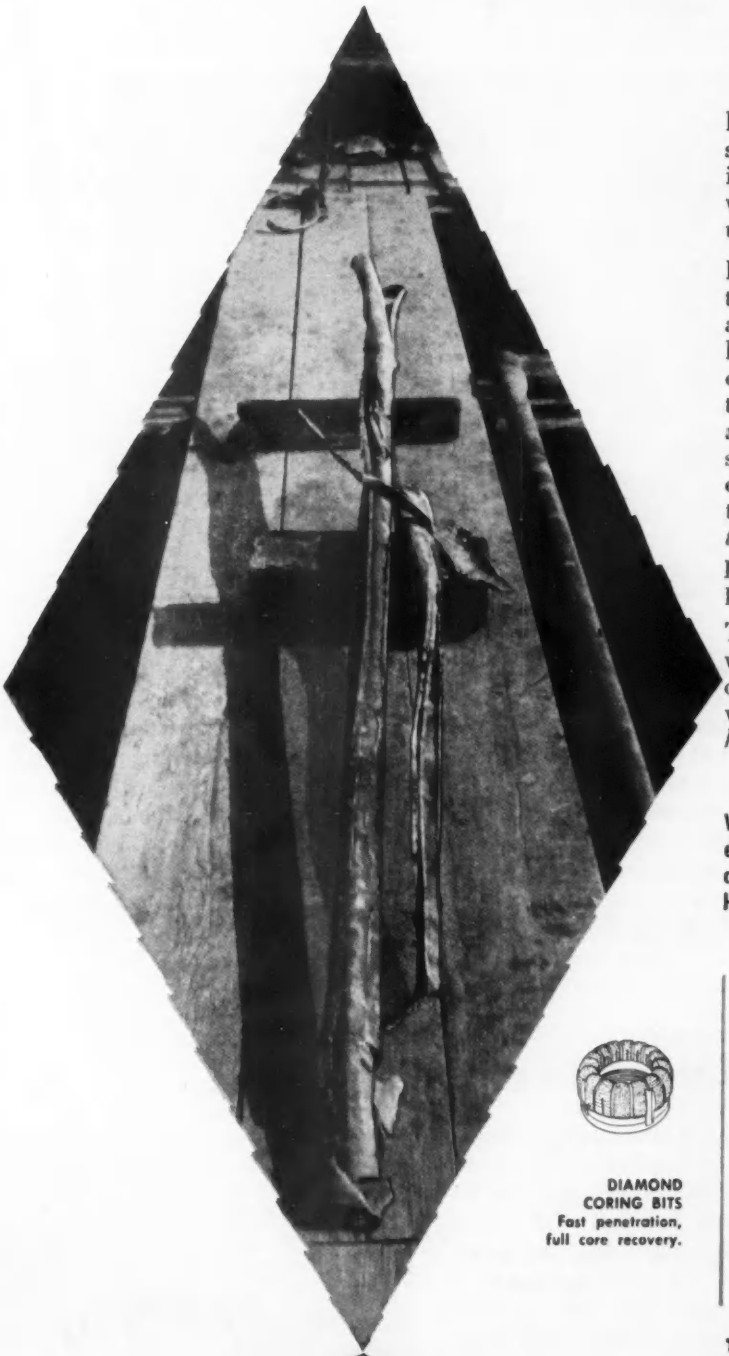

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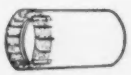

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These **How-To-Do-It** Ideas Can Save You Money

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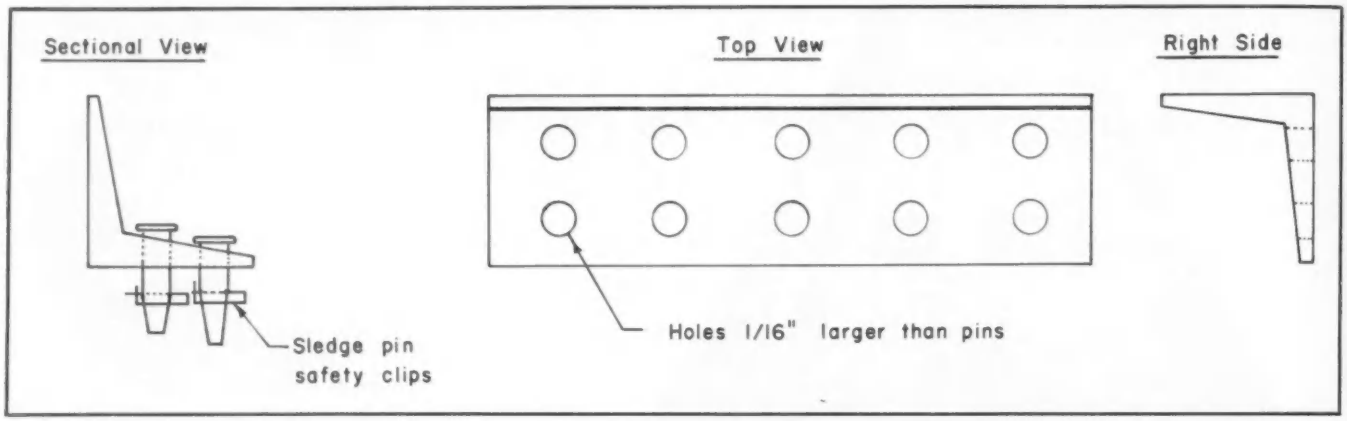


Build Sledge Pin Rack for Easy Checking and Carrying

To provide a fast check of all sledge pins and also a convenient carrying method, devise a sledge pin rack. Use a piece of 6-inch x 6-inch angle iron or piece of flat plate and burn or drill holes in this plate, 1/16 larger than the diameter of the sledge pins. Match these holes to the exact number of sledge pins normally used on the mast and substructure of the jackknife rig.

The rack may be placed in any convenient and out-of-the-way part of the derrick substructure. As the rig is being torn down, slip the pins into the correct sized holes and fasten them with a safety clip.

As soon as the entire rig is dismantled, take a quick look to determine whether all the pins and their safety clips are on the rack. This eliminates the loss of expensive and sometimes hard to replace pins. Install the rack to where the pins are either in horizontal or vertical position, with the horizontal the more desirable position if the safety clip might be missing.

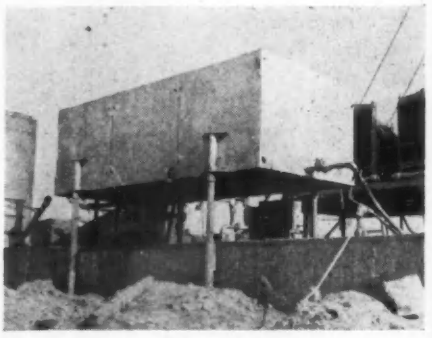
How-To-Do-It Ideas Earn Money, too!

$10—World Oil editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, World Oil, P. O. Box 2608, Houston 1, Texas.

Rest Storage Tank Over Ditch

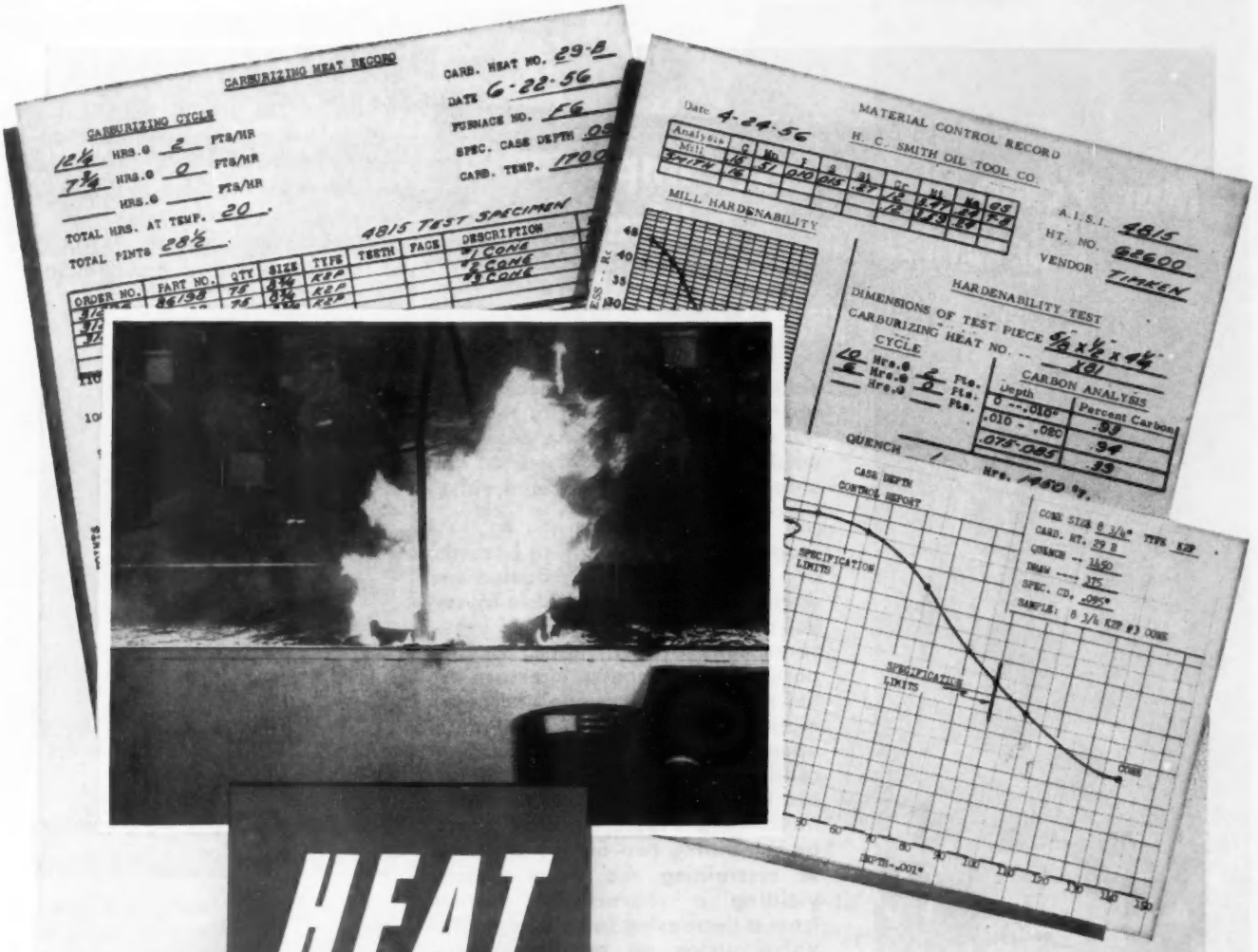
Build an elevated water storage tank that is centrally located, easily installed, requires no ground area for itself and saves time and money. The tank is a rectangular one having the same width as the mud ditch. Rest it on four removable legs directly above the ditch, several feet of open work space existing between the bottom of the water tank and top of the ditch.

Key to the unitized tank are the four short lengths of drill pipe material and the pipe sockets. Weld the latter at corresponding intervals on the sides of the water tank and the sides of the ditch. After the mud ditch is spotted, suspend the water



tank above it by the crane while crewmen insert the four equal-length "legs."

Set down on the legs, the water



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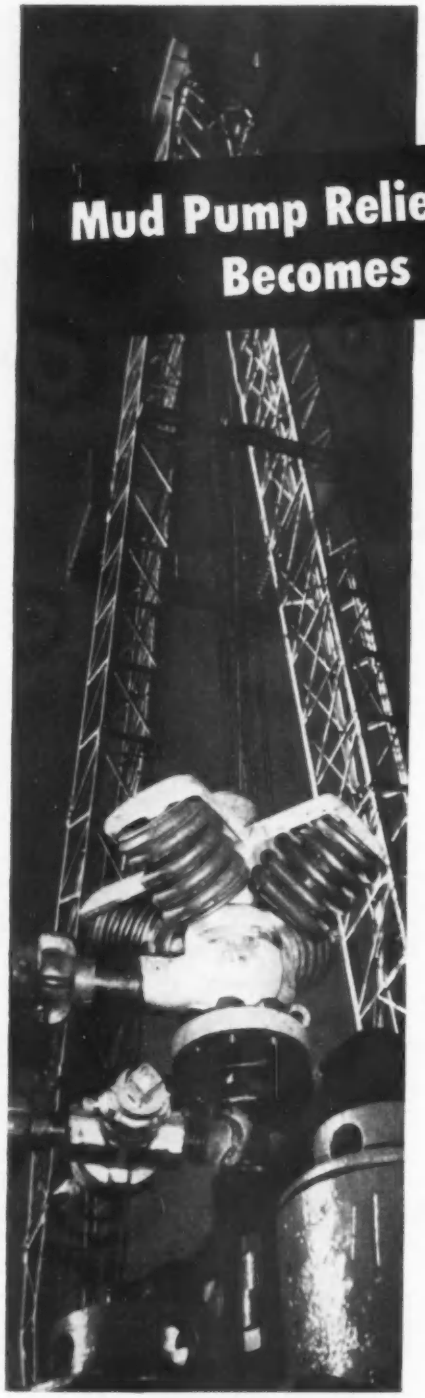

Mud Pump Relief Valve Importance Becomes More Critical

As mud pumps are necessarily operated at near capacity to meet the constantly increasing demands on drilling circulating systems, the safety demands on the relief valve become greater.

Responsibility for reducing hazards of personal injury, equipment damage and drilling trouble by relief of excessive drilling mud pressures, calls for a valve that assures positive instantaneous pressure relief at maximum volume and automatic restoration of circulation upon correction of the overloading condition. These requirements have been accomplished in the Kinzbach Model 112 Pressure Relief Valve by combining two unique methods of restraining the valve piston, yielding a characteristic action from a decreasing force against the valve piston on opening movement, and conversely, an increasing force during closure. This assures higher effective lift during valve action.

When excessive circulating pressures occur, the valve either repeats its cycle of rapid opening and closing, or remains open until the obstruction is removed or the pump stopped. Momentary blocks do not require pump shutdown to reset the valve. Movement of fluid may not be materially affected, preventing danger of stuck drill pipe as might occur with arrested circulation. Compounding Heads are available where pumps are used in series.

Kinzbach Model 112 Pressure Relief Valves are available in 2" and 3" sizes with pressures ranging from 500 psi to 16,500 psi. Write for complete data or consult your new Composite Catalog. Sold through Supply Stores everywhere.

KINZBACH TOOL CO INC

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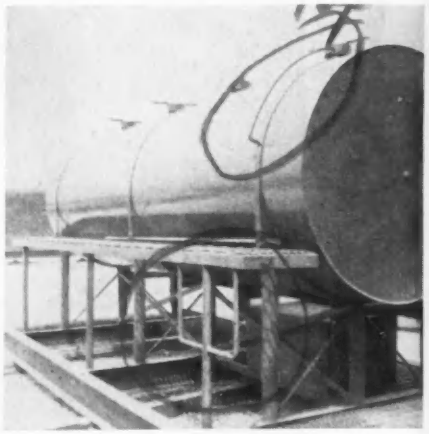
tank is stable and free of wobble. Supported at the height shown, it does not interfere with mud gun operations and being above ground, there is less opportunity for rusting or corrosion to occur on the bottom and bottom corners than there would be if the tank rested on gravel or planks at ground level.



Set Angle Iron Walkway On Skid Platform of Tank

In order to facilitate filling and checking the lubricant tank, install a walkway at a convenient height on the same skid platform as the tank. It can be moved in position when the tank is moved. This walkway, made out of expanded metal, is complete with stairstep access and handrail. All of the material necessary for the walk, step and handrail can be found in salvage material in the contractor's yard.

Build the skid upon which the lubricant tank is mounted extra wide to facilitate the mounting of the walk. Build this walk out of angle iron and cover with expanded metal with 2-inch pipe used as legs. Make the step out of sucker-rod material and weld it to either of one leg and the bottom of the angle iron, as noted in the photograph. Make the handrail out of sucker-rod material and weld it to the tank strap and the filling plug guard.

This provides a safe and convenient method of checking the remaining supplies of lubricants. It also facilitates filling these tanks when it is necessary to handle the hoses from the supply truck, and keeps the crew member from having to climb up the tank.

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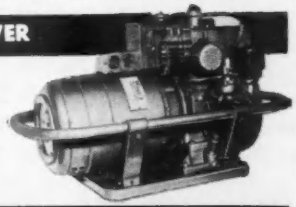

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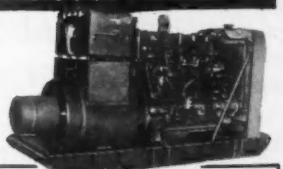

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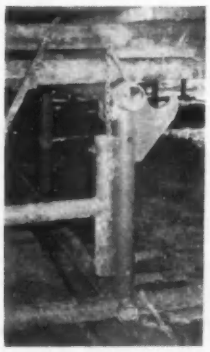
Use Overhead Crane On Christmas Trees

To install blow-out preventers or Christmas trees, extend an overhead crane approximately six feet beyond the substructure and fit it with two dollies. Chain the blow-out preventer to these dollies and run-in under the floor. Release the inside chain. As the sling picks up on the inner end the chain is removed. Then the blow-out preventer is moved in farther toward the wellhead where it can be picked up entirely by the line coming down through the rotary table.

When not in use, or when moving, chain the blow-out preventer in position in the substructure. This method of handling a blow-out preventer is safe, convenient and prevents accidents. The blow-out preventer can be trucked in directly beneath the overhead crane and with the aid of a gin pole can be picked up and chained in position on the dollies. It can then be moved in under the floor in the position shown, where it is ready and available when needed on the wellhead.

Improve Pipe Rack Design With 'T'-Shaped Member

Use an efficient pipe rack, one which requires a minimum of material and welding, yet which is easy to dismantle and load. Make the individual pipe rack sections of drill pipe material: brace them by a "T"-shaped member which, when bolted to the rack, provides not only the exact spacing, but rigidity and assurance that individual sections will not tip or lean should excessive loads or soft ground exist at that point. Attach this horizontal brace at each end by means of only two bolts.



In addition to that feature, equip the rack section, at the driveway end, with a permanent cradle, torch-cut from a piece of ½-inch plate, which provides an efficient rest for pipe skids when drill pipe is being loaded or unloaded.

All-Steel Center Strip Stabilizes Pipe Walk

Make a pipe walk combining the inherent advantages of all-steel construction for strength, plus the added non-skid advantages of plank decking. Build the rack having for its deck an all-steel center strip which facilitates laying down and pulling in

KEEP YOUR MUD IN BALANCE with "Mud-O-Graf"

- Provides accurate information for uniform mud control.
- Helps prevent blowouts by showing the duration and relative amount of gas in gassy streaks.
- Eliminates guesswork in the use of weighting materials, chemicals, and water.
- Indicates graphically all heavy and light streaks in the circulating system.

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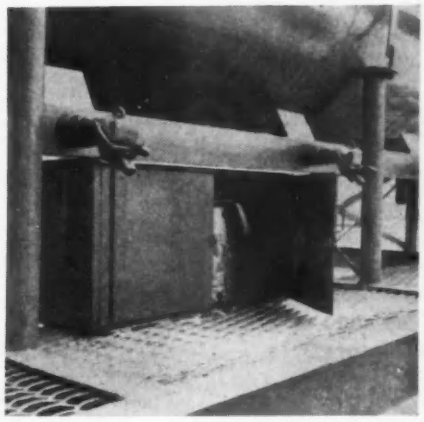
drill pipe or casing, and with a minimum contamination of threads by wood splinters, mud and foreign matter.

On either side of the center strip, however, and held in place by channel and angle material, leave the customary wooden planks, the latter easily turned over or replaced when wear necessitates.



Store Oil Measuring Cans Under Lubricant Tank

For appearance, for safety and to protect the investment in the material, it is best to have a storage place for each piece of equipment and tool around the rig. Build a small storage space under the lubricant tank that is welded to the skid base of the tank. Provide the storage space with doors so that oil measuring cans could be stored inside. Make the storage space out of thin sheet metal around an angle iron box-shaped frame.

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For Light Weight Plus Strength

*Refers to gallons of water required for each cubic foot of Strata-Crete 6

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PRODUCTION HINTS

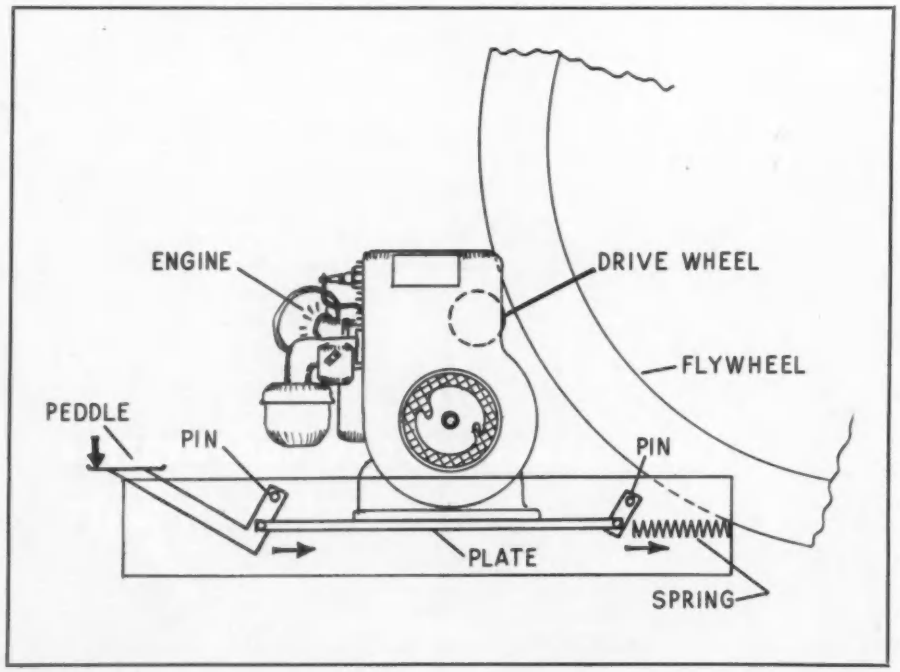
These How-To-Do-It Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Turn Fly Wheel With Small Gas Engine

There is considerable expense to installing an air compressor and accessories for mechanically starting an engine which is difficult to start manually. To reduce expenditure use a small air-cooled gas engine to turn the fly wheel of a large two-cycle, slow-speed engine. Add a reduction gear and heavy rubber wheel to the engine to complete the unit, as shown in the illustrations.

Mount the engine on a steel plate which is suspended by four arms from a metal frame. Pivot the arms, allowing the plate to move backward and forward. When the foot pedal is depressed, the plate pivots toward the rear of the frame, allowing the drive wheel to come in contact with the engine fly wheel. When the pressure on the pedal is removed, two compression springs force the plate in the opposite direction, disengaging the drive wheel. The dimensions for this unit would be dependent upon the position of the fly wheel in relation to the base on which the motor was to be installed.



Set Up Manifold Assembly In Shop to Save Time

To save production personnel time in the installation of manifold assemblies set up a standard and assemble the units in the shop. In the illustration a complete unit has arrived in the field ready for installation. In this case a considerable reduction in time and expense was achieved by the operator who took advantage of shop equipment and personnel to assemble a piece of field equipment.

How-To-Do-It Ideas Earn Money, too!

$10—World Oil editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, World Oil, P. O. Box 2608, Houston 1, Texas.

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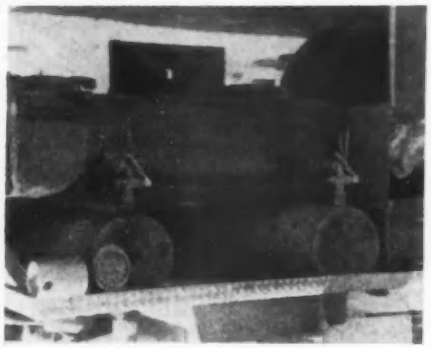
PT-8

Carry Small Tanks Under Truck Bed



To eliminate the necessity of carrying cans of kerosine and paraffin solvent on a pulling unit, install small tanks under the bed of the truck. Make the tanks from old casing, cut to fit between the truck frame and the outer edge of the truck bed. Weld a plate at each end of the casing. Weld a 2-inch collar to the casing in such a position that it will extend through the truck bed and provide an inlet for the fluid. On the opposite side of the casing, extend a 1-inch collar downward to fit with a valve, as illustrated in the photograph.

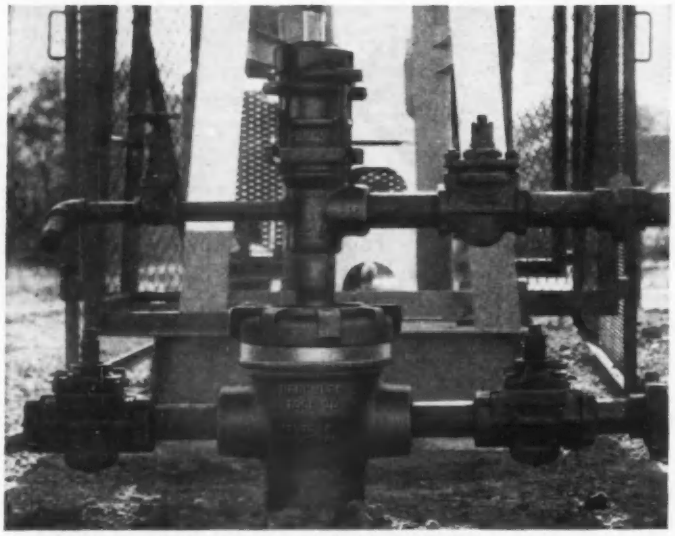
Install these tanks by welding the 2-inch collar to the top of the truck bed, where the bed is metal. Tack-weld the top of the tank to the underside of the metal truck bed, and weld the end of the tank to the truck frame. In cases where it is impossible to weld the tanks into position, weld metal strips to the tank and bolt them to the truck bed.

This set-up keeps cans from being borrowed or lost and allows a sufficient volume of fluid for a normal day's work. As a secondary feature, the job looks much neater without the usual collection of kerosene and solvent cans lying around.

Add Stand and Shelf To Centrifuge Tank

Make a stand for a gas-driven centrifuge of 4-inch tubing. Weld a quarter-inch steel plate to the top of the tubing, to which the legs of the centrifuge are bolted. The real innovation in this design is the small shelf attached to the side of the tubing for a gas can. To add this shelf, cut a quarter-inch slot one-third of

What the WELL-DRESSED, MEDIUM-PRESSURE Wells are wearing



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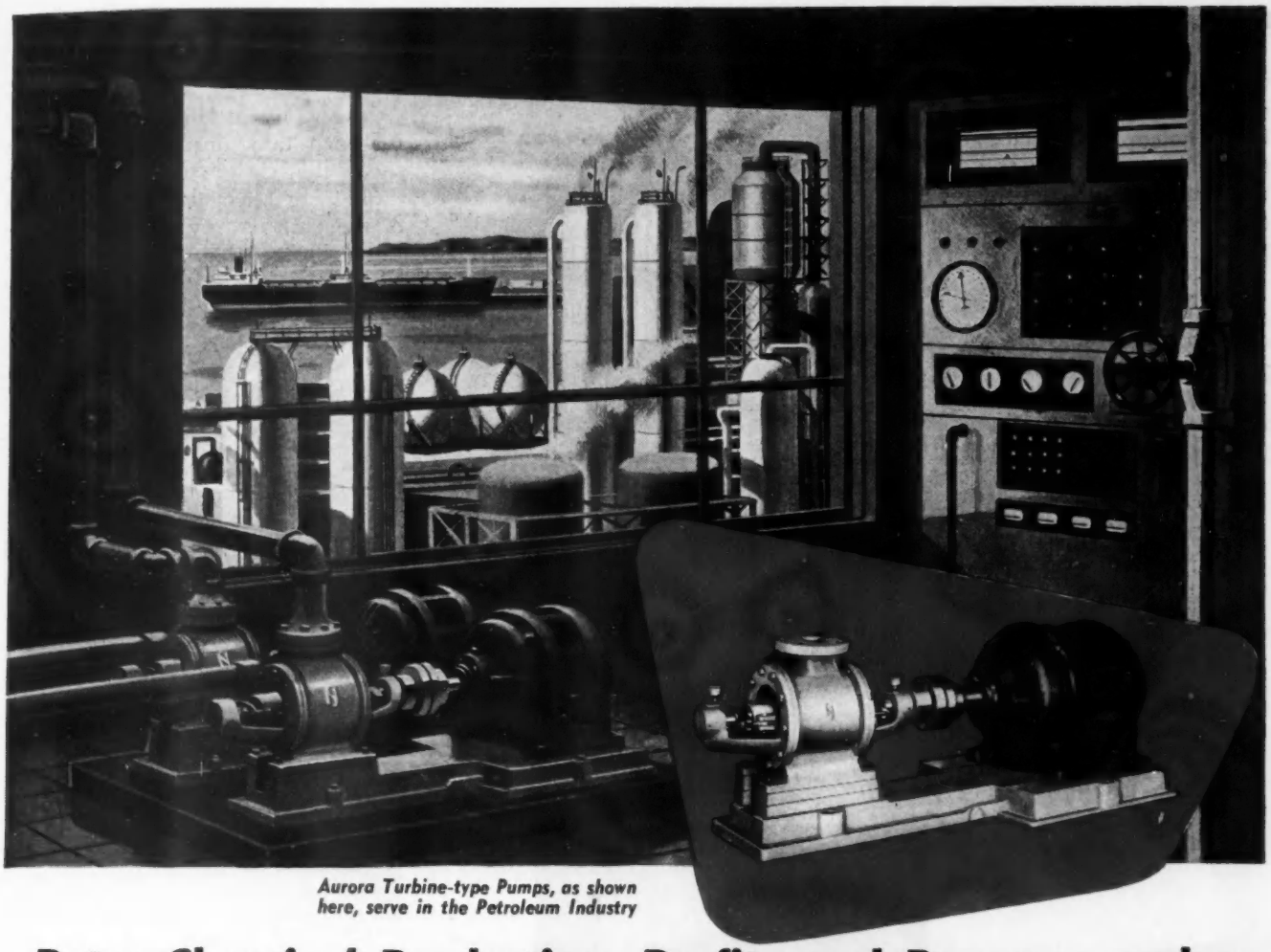

Aurora Turbine-type Pumps, as shown here, serve in the Petroleum Industry

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Finally there are KINNEY High Vacuum Pumps and complete Vacuum Systems in laboratory and high production sizes for distillation, dehydration and de-aeration.

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the way through the tubing. Into this slot place the edge of sheet steel disc large enough in diameter to accommodate the vessel you require. Then weld the disc into place and the job of providing a handy shelf is complete.

This system provides a definite place for the gasoline, close to the centrifuge, and eliminates the necessity of carrying the gas can around in a car or truck, or storing it at some inconvenient place in the area.

Corner Lightning Rods Simplify Tank Protection

Instead of installing separate rods for each tank, install four rods to serve the entire tank battery. By positioning them at the four corners of the tank battery and about three times higher than the top of the tanks, the protection job is greatly simplified.

Emergency Surge Tank Helps Water Pumping

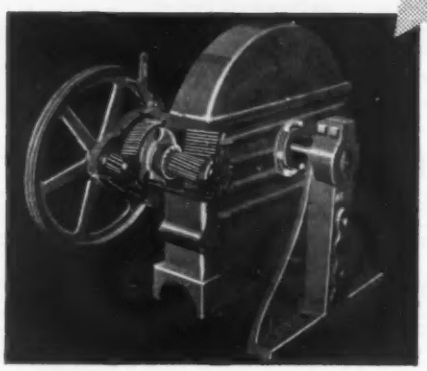
Water, often a difficult thing to pump, can cause considerable stuffing box trouble when put through a meter at the wellhead. To reduce this trouble, install an emergency surge tank, as shown in the illustration. The material needed for its construction consists of two 2 by 3-inch swages, two 3-inch collars, a short 3-inch nipple and a 2-inch valve. Assemble these, and install the unit between the wellhead and the meter. The shock usually placed on the stuffing box is taken up by the surge tank which greatly reduces wear on the stuffing box.

Construct Pipe Supports In Assembly-Line Fashion

Construct a pipe support from a piece of used 2-inch pipe and a short section of angle iron. The length of these pieces depends on the height at which the supported pipe is to be

Change Speed Reductions

QUICK! . . .



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A JENSEN is without question the most versatile and practical pump jack you can buy.

Changing gear reductions, from single to double or from double to single, is a quick one-man operation requiring no major mechanical alterations and a minimum of downtime.

The JENSEN one-man counterbalance, double tapered roller type bearings, precision shaved gears and oil bath lubrication are other features that add to the functional design and trouble-free operation of a JENSEN JACK. See your dealer or write us for detailed information.

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Used in All Drilling Areas- with Complete Satisfaction . . . . . .

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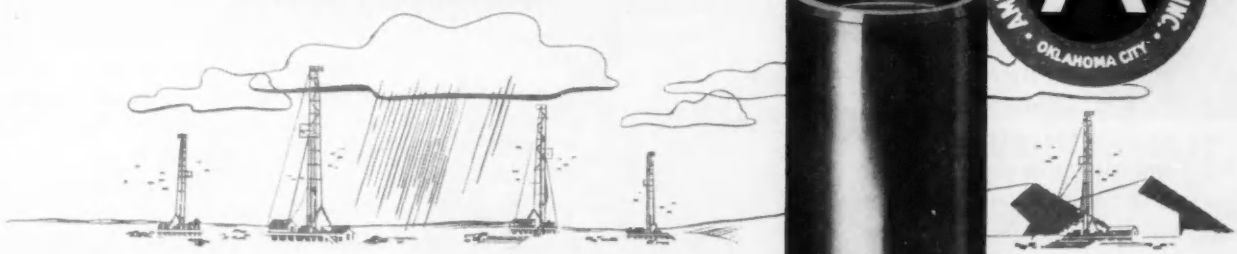

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GOTKOOL Water Cans and Coolers are easily portable for field use, and are ideal for use in office, store, and plant. Both **Gotkools** have extra large top openings. Snug-fitting, easily removable top protects drinking water from dust and contamination. Heavy construction with double-locked, sweat-soldered seams. *Buy* **Gotkool** *at your supply store today.*

GOTKOOL Water Cooler – made in 1½-, 2-, 3-, 5-, 10-, 15-, and 20-gallon sizes with either extended or recessed, flush-mounted faucet. *Note:* 15- and 20-gallon sizes available with extended faucet only.

GOTKOOL Water Can – made in 1½-, 2-, 3-, 5-, 10-, 15-, and 20-gallon sizes without faucet.

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WINFIELD, KANSAS

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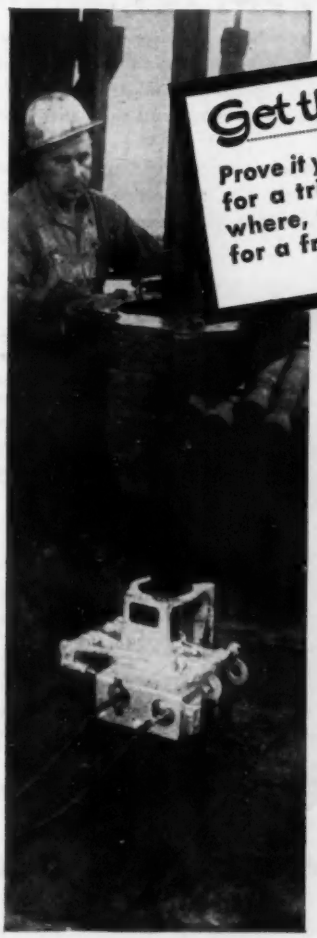

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Lubricate Polished Rods With New Reservoir

held above the ground and the diameter of the supported pipe.

To construct these supports, cut an arc in one side of the angle iron to fit the contour of the pipe being supported. Weld the 2-inch pipe to the other face and the unit is complete. The flat, horizontal surface of the angle iron allows the pipe support to be driven into the ground with a sledge hammer without defacing the section of the bracket supporting the pipe.

This sort of design allows a number of supports to be made up before hand and cut to the appropriate length when a site for their use has been decided upon.

For adequate lubrication for polished rods a reservoir similar to the one illustrated comes in handy. It provides a much larger quantity of lubricant than is usually afforded in regular stuffing box.

Alter the dimensions of this unit to meet the requirements of a particular well. An ideal situation, however, is to weld a 2-inch nipple about 4 inches long to the top of the stuffing box and then weld the reservoir to the nipple. Make the reservoir of a piece of 6- or 8-inch casing, about 6 inches long. The nuts welded on the side are used to fit an oil stripper to the top of the reservoir. Two bolts pushed through the ends of strip of heavy asbestos fabric strip the excess oil from the rods and prevent it from being blown about by the wind.

This method of lubricating the polished rod allows the use of a large quantity of cooling fluid, thereby reducing the possibility of overheated polished rods due to lack of sufficient lubricant.

"SOMEBODY HAS TO PAY FOR IT—UNLESS IT SHOWS UP IN THE SHAKEOUT."

"Mr. Oil Man, are you getting true tests on your oil? Are you paying for oil you don't get? Are impurities taking part of your allowable? Are you paying the expense of handling impurities? Are your samples being shaken out at the proper speed, and are they at the proper temperature at the end of the shakeout?

"Test your good or bad oil the usual way, and then test it with the Melton Heating Centrifuge. The results of the Melton test will really surprise you."

One major oil company found enough difference in one tank of oil to pay for one Melton Heating Centrifuge. Another company estimates it found a difference of 19% in testing one "tank bottom." We know that we can save you money. Don't wait. The Melton Heating Centrifuge can pay for itself many times by giving you a true test on the oil you handle. Find out now by ordering one or more.

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Patent Pending
Model B-2 (6 Volt)

They heat oil samples maintaining heat before and during rotation, obtaining a true test. Now being used by twenty-six oil companies in the United States, Canada and South America.

Fully guaranteed against failure of any part of the entire unit for one year from date of purchase.

Model A-2-6 for 6 volt batteries
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Model B-2-6 for 6 volt batteries
Model A-2-12 for 12 volt batteries
Model A-4-12 for 12 volt batteries
Model B-2-12 for 12 volt batteries
Model A-2-6-S for 6 volt batteries
Model A-4-6-S for 6 volt batteries
Model A-2-12-S for 12 volt batteries
Model A-4-12-S for 12 volt batteries
Model B-2-6-S for 6 volt batteries
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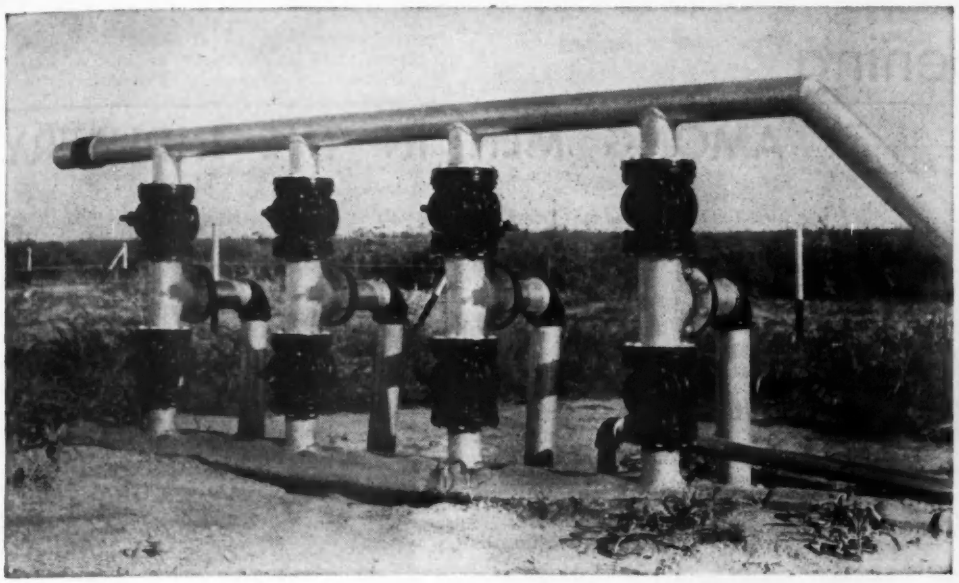
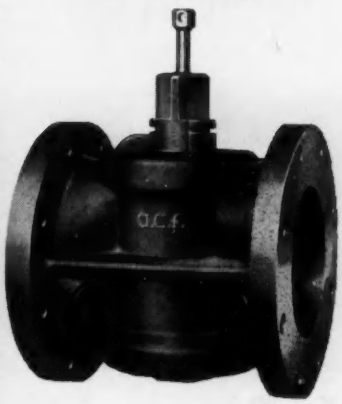


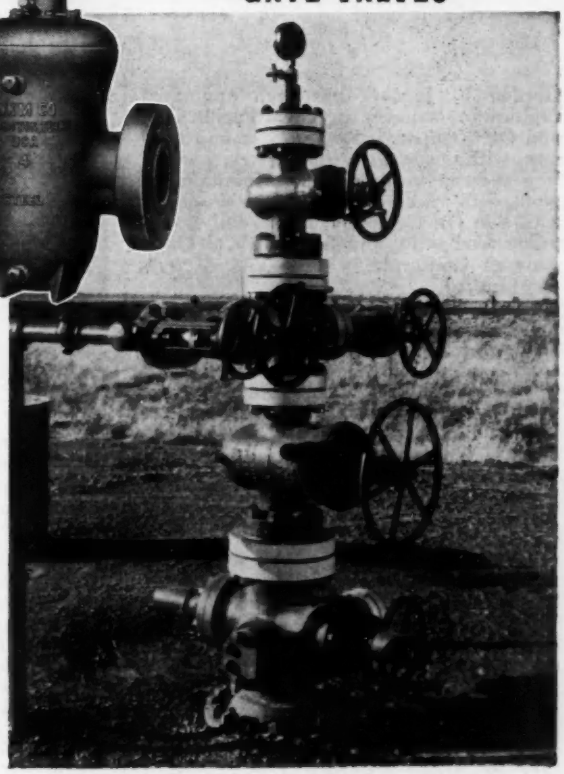
acf LUBRICATED PLUG VALVES



NOW-

Both High and Low Pressure Valves from W-K-M

W-K-M THROUGH-CONDUIT GATE VALVES



For your Christmas Trees, flow lines, and wherever else high pressures must be safely and positively controlled, there are the famous W-K-M- through-conduit gate valves, in working pressures from 1,000 to 15,000 pounds.

acf lubricated plug valves, of steel, semi-steel, and special metals, with round or rectangular ports, in working pressures from 200 to 500 pounds — are the perfect companion valves for gathering lines, manifolds, headers, and similar low pressure installations.

Because you need the finest in service wherever valves are required, you will be way ahead when you specify W-K-M or acf valves for their respective applications.

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W-K-M THROUGH-CONDUIT GATE VALVES

acf LUBRICATED PLUG VALVES

KEY RETURN BENDS AND FITTINGS

What's Happening

AMONG MEN IN THE INDUSTRY

N. H. Wheless

R. V. Pierce

Wheless Drilling Company announced the election of **Nicholas H. Wheless, Jr.**, as president and **R. V. Pierce** as vice president. **N. Hobson Wheless,** formerly president, has become chairman of the board. Wheless joined the company in 1938. Pierce joined in 1943 and has been in charge of Gulf Coast operations since that time.

•

Gordon E. Jacober has been appointed exploration manager for **Texas Pacific Coal and Oil Company's** Rocky Mountain division, with headquarters in Denver. Jacober is a veteran in the Rocky Mountain region, with eight years' geological service with Sun Oil Company, Husky Oil & Refining Company, and Standard Oil Company of California.

•

Socony Mobil Oil Company, Inc., recently announced the election of **Arthur M. Sherwood** as secretary of the company. Formerly assistant secretary, he will succeed **William D. Bickham** who retired July 1 after 27 years of service. Also retiring July 1 after 29 years was **Paul J. Buttles,** who has been an assistant secretary. **Theresa Jean Lutz** and **James J. McKay** have been elected assistant secretaries to succeed Sherwood and Buttles. Sherwood joined the company in 1954 from the law firm of Shearman & Sterling & Wright, New York. He served in Socony Mobil's office of general counsel until his election as an assistant secretary last November. Lutz joined the company in 1929 and has been employed continuously since then in the secretary's department. At the beginning of 1956 she was named an assistant secretary of Mobil Overseas Oil Company, Inc., a wholly-owned affiliate. McKay recently joined Socony Mobil after five years as assistant secretary of Sperry Rand Corporation.

•

Reserve Oil and Gas Company has announced the appointment of **Robert P. Mangold** as manager of field operations to replace **Max C. Eastman,** who recently was promoted to executive vice president with offices in San Francisco. Mangold's headquarters will be in Bakersfield. Mangold was with the United States Geological Survey several years beofre joining a major oil company where he worked in all phases of oil exploration and production both in the U. S. and South America. For the past four years, he has been operations manager for the several D. K. Partnerships which have been engaged with Reserve in various joint ventures.

•

Dr. Clifford W. Seibel directs the only large-scale helium production activities in the world. Frequently referred to as "Mr. Helium," his official title is assistant director of helium in the **Department of Interior,** Amarillo. It has been principally through his efforts in the Federal government program that this previously rare gas is now so important in modern developments. In 1930 Dr. Seibel became supervising engineer of the Amarillo plant.

•

R. Scott Graham, petroleum engineer, now is associated with **John S. Herold, Inc.** Graham formerly was with Creole Petroleum Corporation and Carter Oil Company, both affiliates of Standard Oil Company (New Jersey), as production and reservoir engineer.

•

Harry L. Arnold, an attorney with The Carter Oil Company, has been appointed to the law department staff of **Standard Oil Company (New Jersey).** Arnold was assistant attorney general of Illinois before joining Carter, an affiliate of Jersey Standard, in 1946. His first assignment with Carter was Eastern division attorney at Mattoon, Ill. In 1949 he was appointed assistant to the president of Carter, and in 1952 became executive assistant to its vice president in charge of Northwestern operations. Three years ago he returned to Carter's law staff.

Harry L. Arnold

•

Allyn R. Bell, Jr., controller, **General Crude Oil Company,** has been elected a vice president of the Controllers Institute of America, effective September 1. He was president of the Institute's Houston Control in 1953-54, and was elected a national director in 1944. He has been a member of the Institute since 1944.

•

Southwest Gas Producing Company, Inc., announces the following changes in personnel: In the general office at Monroe, La., **Arthur H. Smith** was appointed manager of the Land department and **Barney F. Pate,** geologist. At Lafayette, La., **A. E. Beasley** was appointed manager of the district office, and **Joseph F. Moss,** formerly with Sun Oil Company, was named district geologist.

•

Robert E. Kingsley joined **International Petroleum Company, Ltd.** July 1 as public relations advisor. He joined the Marketing Coordination department of Standard Oil Company (New Jersey) in 1948, and was managing editor of International Esso Oilways and of Esso Exchange. He transferred to Area Contacts of Public Relations in 1954.

Robert W. Pack is retiring from Sun Oil Company after nine years as director of production and as a director of the company. For almost 39 years he has been a key figure in Sun's production organization. Pack's retirement is effective August 1. With the U. S. Geological Survey seven years, he served successfully as assistant and associate geologist, palentologist and geologist in charge of geologic work down by the Survey in the California oil fields. He joined Sun in 1917 as a geologist. In 1920 he was named general manager of the Gulf Coast division and was elected vice president and general manager of Sun Pipe Line Company (Texas). In 1947 he was made a director of Sun Oil Company, and later that same year, was appointed director of production.

Robert W. Pack

•

Ambassador Oil Corporation has announced that **C. Harrison Cooper** has been elected executive vice president and a member of the Executive Committee. Cooper succeeds **Luther Hudson** who resigned June 15. Hudson, who will act as general counsel for Ambassador, will resume his law practice with the firm of Hudson, Keltner and Sarsgard.

•

Frank M. Porter, president of the American Petroleum Institute, recently was awarded an honorary degree of Doctor of Laws by Hahnemann Medical College and Hospital of Philadelphia. Porter was presented as a candidate for the degree by Robert G. Dunlop, president of Sun Oil Company and vice president of the college's board of trustees. The degree was conferred by Watson Malone, president of the board of trustees.

•

Sunshine Mining Company, Petroleum division, has announced the appointment of **Ernest S. (Bill) Wells, Jr.,** as division manager of the Denver division. Wells recently moved to Denver from Oklahoma City where he was manager of land and leases for Macmillan Petroleum Corporation. **Nolan H. Ashburn** has been named division geologist, and **George L. Gear,** formerly with Natural Gas and Oil Company, has been named division production superintendent.

Ernest S. Wells

•

James H. Wuller has been appointed secretary of the **Skiles Oil Corporation.** He also continues as head of the company's Legal department.

Chas. A. Perlitz, Jr., Houston, senior vice president and a director of **Continental Oil Company**, has been elected executive vice president. Perlitz joined Continental in 1946 as general attorney. He was elected a company vice president the same year, a director in 1947, and senior vice president in 1953. Before joining Conoco, he was associated with Strake Petroleum, Inc., in Houston seven years and a Houston law firm nine years. In addition to being executive vice president and director of Continental Oil Company, he is a director of Great Lakes Pipe Line Company; Hudson's Bay Oil and Gas Company, Ltd.; Petroleum Chemicals, Inc.; Sahara Petroleum Company; Continental Oil Company of Libya; and the Texas National Bank Building Company, all of which are Conoco subsidiary or affiliated companies.

Chas. A. Perlitz, Jr.

•

Standard Oil Company of Texas has announced the election of **C. D. Mims** as a director of the corporation and as vice president in charge of production. Joining Standard of Texas as a petroleum engineer in 1946, he was field foreman in 1949 during development of the Kelly-Snyder field in Scurry County. In 1952 he was made vice president in charge of production for The California Standard Company, a subsidiary of Standard Oil Company of California. **L. A. Swanson**, chief engineer for Standard of Texas, has accepted the position of vice president formerly held by Mims with The California Standard Company.

•

W. O. Spencer, landholder and rancher of Pittsburg, Texas, **Ed Peterson, Jr.**, North Texas oil operator and partner in the oil operating and producing firm of Peterson and McCarty, and **B. D. Tucker**, Houston financier, have been named directors of **Seaboard Oil and Gas Company** of Wichita Falls, Texas. Spencer, now vice president of the Upshur County Rural Electrification Administration, formerly served as president of the organization and has been a member of the board of directors since its establishment. He has extensive livestock, timber and oil and mineral holdings in Camp, Franklin and Wood counties, Texas. Peterson has had almost 20 years' experience in the oil business which he first entered as a roughneck and roustabout. He has drilled oil and gas wells in Colorado, Oklahoma, New Mexico and north Texas. Tucker is president of the Oak Forest Investment Company, president of the C & T Building Company, and a partner in the fire and hazard insurance agency of Tucker and Watts. He is also president of the ANB Corporation, a land development firm.

•

Warren M. Albert, assistant to vice president of Magnolia Petroleum Company, became an assistant comptroller for **Socony Mobil Oil Company, Inc.**, with headquarters in New York July 1. Magnolia is the southwestern affiliate of Socony Mobil. Albert began his career with Magnolia in 1928 as an office boy in the general offices in Dallas. He worked in various clerical and accounting jobs there and in Texas

Every oil magazine . . . every newspaper and news magazine . . . points up the tremendous job that Joe Roughneck is doing to supply the fantastic quantities of oil and gas required today.

Joe, symbolic spirit of the oil industry, may be on a rig in the field or running a company from the home office . . . but he knows oil and pipe.

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M. M. Kinley Company, Licensees

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CORPUS CHRISTI
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MIDLAND
Luccous Service & Equipment Co. ---------- 2-1631
PETTUS, TEXAS
Eddie Jones Engineering Co. -16 or Beeville 1547
OKLAHOMA CITY
Rainbo Service Co. ---- ME 4-2131, ME 2-3045
LIBERAL, KANSAS
Rainbo Service ---------- Main 4-3598
WICHITA FALLS
Hudson-Eads, Inc. --- 2-3767, 2-8584, 3-4690
CASPER, WYOMING
C. A. White ---------- 3-5264
GLENDIVE, MONTANA
C. A. White ---------- EMpire 5-3833
FORT MORGAN, COLO.
C. A. White ---------- 919

oil fields until 1942 when he was transferred to the comptroller's department in Dallas. He was made assistant comptroller in 1950, and in 1954, was promoted to his present position as assistant to the vice president.

Charles B. Wallace succeeds **Earl A. Brown** as general counsel of **Magnolia Petroleum Company.** Brown, who also was a director and vice president, retired July 1. Wallace has been on the company's legal staff since 1939 and has been in charge of litigation for Magnolia companies since 1951. Named associate general counsel for Magnolia was **R. T. Wilkinson, Jr.,** a member of the companies' legal staff since 1940. Brown practiced law in Texas and Oklahoma from 1914 to 1920 when he became associated with a firm that represented Magnolia in southern Oklahoma. In 1936 he joined the company's legal staff in Oklahoma City and after three years was transferred to Magnolia's general offices in Dallas as assistant general counsel. He was appointed general counsel in 1951.

Shell Oil Company's Technical Services division announces that **Dr. Charles S. Matthews,** senior chemist in Shell Development Company's physical department, will transfer to Production Technical Services as chief reservoir engineer. He replaces **A. G. van Everdingen,** who will transfer to the head office staff of Exploration and Production in New York. **G. E. Archie,** formerly chief logging engineer, has been named assistant manager of Production Technical Services. **M. M. MacQuarrie,** senior exploitation engineer and formerly assistant to the vice president of Exploration and Production in New York, has been appointed chief coordinator of technical recruiting. Dr. Matthews joined Shell

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NEW
CLAYTON MARK & COMPANY
TABBED ORIFICE UNIONS

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Works in seconds! Loosens Rusted Bolts
nuts, screws, "frozen" parts .... without breakage!

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Makes joints LEAKPROOF!
7 BASIC BLENDS

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GASKET & JOINT SEALING COMPOUND

Makes all assemblies leakproof and pressure-tight. Easy to apply with brush-in-handle.

● NON-SOLVENT—WILL NOT HARDEN
● WILL NOT SHRINK, CRACK OR CRUMBLE
● HEATPROOF AND VIBRATION-PROOF

Get them at Industrial or Oil Field Supply Houses.

RADIATOR SPECIALTY CO.
Charlotte, North Carolina

Development in 1944, transferring in 1948 to the Exploration and Production Research division in Houston. Van Everdingen joined Shell in 1925 as a hydrologist for the Curacao Refinery, Dutch West Indies. Since 1937 he has lived in Houston, carrying out temporary assignments to South America and The Hague for consulting work on reservoir engineering problems. Following initial training assignments in the Mid-Continent area, Archie, who joined Shell in 1934, was assigned to the Kansas division where, in 1937, he was promoted to district engineer. He transferred to the Texas-Gulf area in 1939 to undertake a study of logging problems and was appointed chief logging engineer with Technical Services in 1951. MacQuarrie joined the company in 1928 as a junior exploitation engineer in West Texas. He was chief exploitation engineer in the Mid-Continent area at Tulsa until 1946 when he was transferred to New York.

•

C. B. Smith, Oklahoma district geophysicist for **Sohio Petroleum Company**, is being promoted to Mid-Continent division geophysicist. He replaces **R. D. Roberts** who is being promoted to manager, Calgary.

•

Earl A. Nichols' appointment as consulting engineer for the newly-organized **Stekoll Properties** has been announced. He will supervise the analysis of oil and gas leases offered to the company, which was formed in May for the purchase and operation of producing properties. Nichols' services will augment the engineering facilities and staff of Stekoll Petroleum whose research department has been made available to Stekoll Properties. After three years as junior engineer for Carter Oil Company in Oklahoma, Nichols joined Core Laboratories in Dallas in 1941 and later became assistant to the president and manager of the Mid-Continent division of all operations. He became an independent petroleum consultant in 1947, specializing in valuation work, reservoir engineering studies, unitization engineerng and water-flood projects.

Earl A. Nichols

•

Drilling and Exploration Company, Inc. has announced the promotion of three supervisory employes to the position of vice president with headquarters in the company's offices in Houston. They are **E. A. Roberts, Jr.**, production manager; **George I. McFerron**, chief geologist; and **Dr. William A. Gorman**, exploration geologist. Roberts has been with Drilexco since 1945, joining the firm as district engineer at Hobbs, N. M. Before assuming the production manager's post at Houston, he was production superintendent in West Texas and New Mexico and general production superintendent for all areas. Prior associations were Geo. F. Getty, Inc., Skelly Oil Company and Republic Petroleum Company. As production manager, Roberts is in charge of all field activities and the co-ordination of the engineering, producing and purchasing departments. McFerron has been chief geologist for Drflexco for the last four years. Before that he was division geologist for Sohio Petroleum Company and a member of the firm of Wiggins & McFerron Oil Company. From 1927 to 1944 he was vice president of Adams Oil & Gas Company. Before joining Drilexco two years ago as exploration geologist, Gorman was vice president of Rycade Oil Corporation and prior to that, manager of Royal Oil & Gas Corporation.

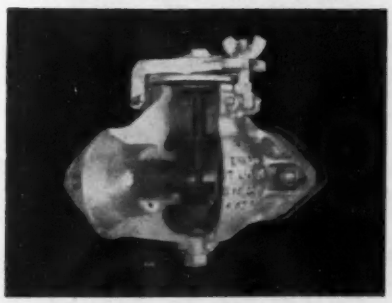
•

I. Q. Rayburn, formerly of Humble Oil and Refining Company, has joined **International Petroleum Company, Limited**, as Systems and Methods advisor in the Comptroller's department. With Humble, Rayburn served in a variety of assignments in production operations, in the Budgets and Reports division of the Comptroller's office, and as acting division head, Methods and Procedures.

Dewey E. Williams has been appointed superintendent of land and inland barge operations of the Louisiana division of **Loffland Brothers Company** it was announced. Williams began his career in the oil well drilling industry in 1941 when he joined Loffland Brothers. He was employed in Louisiana and Mississippi until he was transferred to Venezuela as a driller. He was also in charge of operations in Peru.

D. E. Williams

Enardo 1900 Series In-Line Vent Valve



Enardo 800 Series In-Line Vent Valve

Contact the representative nearest you for further information.

Jack Merrill Henderson, Texas	Harry Higginbotham Tulsa, Oklahoma
W. R. Lee Midland, Texas	K. S. Drane Houston, Texas
Jack D. Neff Ellinwood, Kansas	Bruce Heller Tulsa, Oklahoma

Are you still looking in the sky for profit losses? Enardo Vent Valves provide a means of keeping a predetermined pressure on stock tanks. These vent valves are used in conjunction with Enardo pressure type hatches. Set 2 to 4 ounces less than hatch pressure to prevent hatch venting.

On leases not using a positive venting system, that have changed to an Enardo Vapor Control System, it has been proven that there was an immediate increase in saleable fluid gravity. For, on a lease with a production of 50 barrels per day, it is possible to add a total savings of $1,482.00 in the books after the installation of proper hatches and vent valves, cutting gravity and volume loss.

Enardo 800 series Vent Valves are offerred in standard 2", 3" and 4" pipe sizes, pressure settings ½ to 16 ounces. Featuring aluminum or semi-steel bodies with plastic trim. Slip-On or flanged ends. Standard valve is 1 ounce pressure, 4/10 ounce vacuum.

Enardo 1900 series Vent Valves also offered in 2", 3" and 4" sizes, with or without companion flanges bolted on. Standard valve 2 ounce pressure, 4/10 ounce vacuum. Pressure settings from 2 to 24 ounces.

ENARDO manufacturing company

BOX 1647 TULSA, OKLA

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

R. E. Dalbeck has been elected assistant comptroller of **Union Oil Company.** Until his recent transfer to Los Angeles headquarters, he had been division accountant for Union's Gulf division at Houston.

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J. D. Freese, petroleum engineer for **Warren Petroleum Corporation** at Abilene, Texas, has been transferred to the corporation's Houston office. Announcement also has been made that **Joe R. Black, Jr.,** formerly with Ohio Oil Company in Bakersfield, Calif., has joined the Warren organization as a reservoir engineer for the Sharon Ridge Canyon Unit at Snyder, Texas.

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L. W. (Bill) Goudy, newly-appointed chief geologist for **Vickers Petroleum Company, Inc.,** formerly was district geologist for Stanolind Oil and Gas Company, in charge of the company's Wichita district, which covers Kansas, Iowa, Missouri, eastern Nebraska, the Oklahoma Panhandle and southeast Colorado. He had been with Stanolind since 1940.

L. W. Goudy

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C. Haines Finnell has been appointed director of public relations and advertising for **Union Oil Company of California.** Personnel in the Public Relations and Advertising department will remain the same.

Augustus C. Long

J. S. Leach

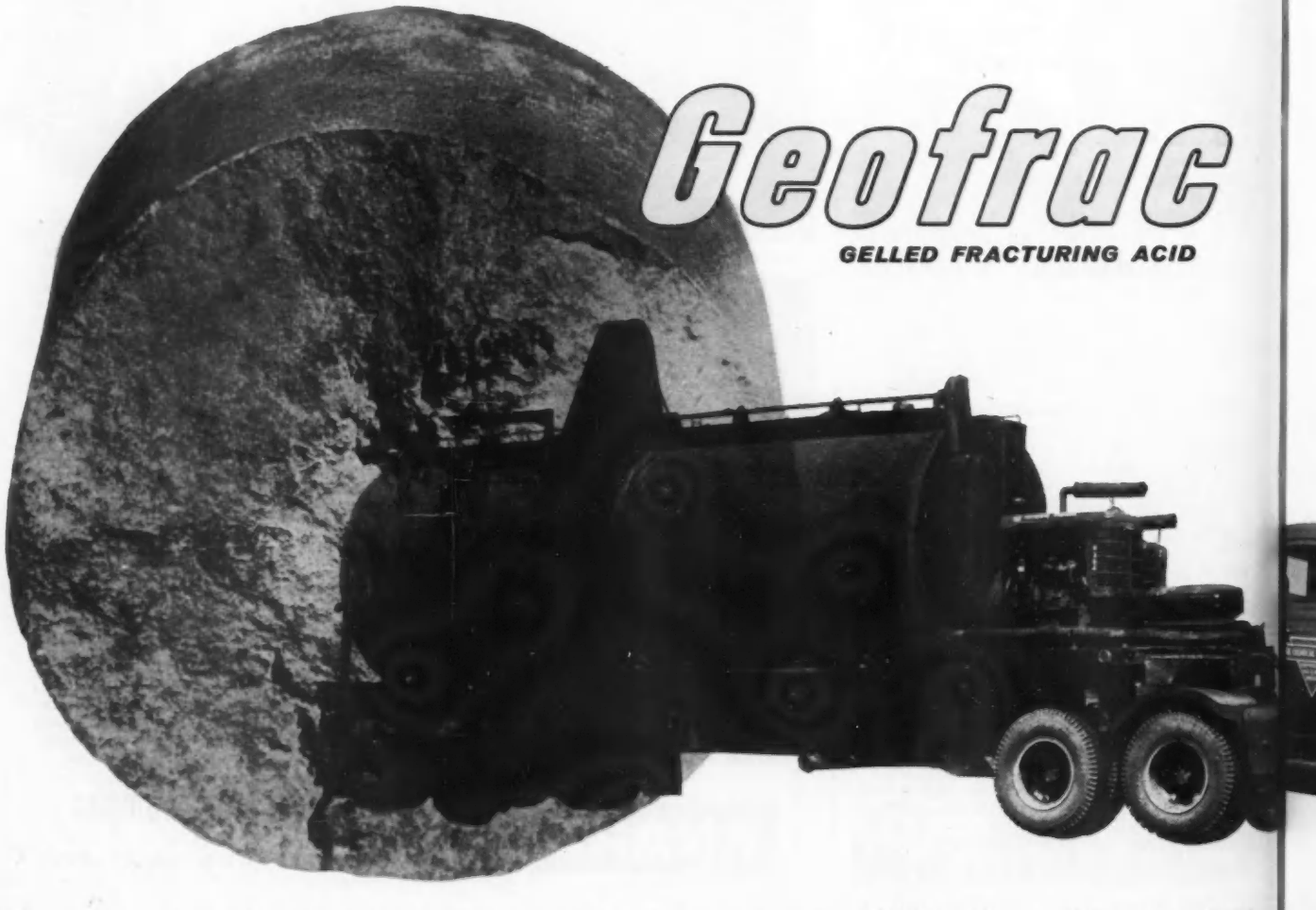
J. S. Leach, chairman of the board of directors of **The Texas Company,** announced recently that he will retire from active service October 1. **Augustus C. Long,** president of the company since 1953, has been elected chairman and chief executive officer, effective October 1. **James W. Foley,** executive vice president since 1955, will succeed Long as president. Upon his retirement, Leach will have completed 40 years with the company. He will continue as a member of the board of directors. Long joined the company in 1930, serving in both domestic and foreign departments until he became executive vice president in 1951. He was elected vice president in charge of foreign operations—Eastern Hemisphere in 1949, and a director of the company a year later. In 1953 he was elected president and a member of the Executive Committee. Foley joined Texaco in 1932. After service with affiliated companies abroad, he held various positions in the Domestc Producing department. In 1950 he was appointed assistant to the chairman of the board; in 1953, a vice president; in 1954, a director; and in 1955, executive vice president.

•

E. L. Estabrook, pioneer in petroleum engineering, has been engaged by the American Petroleum Institute as editor of the Division of Production's History of Petroleum Engineering. He will coordinate historical data assembled by a special committee headed by D. V. Carter, Magnolia Petroleum Company. The volume, which will be concerned almost entirely with American developments, views petroleum engineering as a composite of all types of engineering and science which have contributed to economy and efficiency in drilling for and producing oil. Estabrook was active in petroleum engineering and geology from 1911 until retirement from the Standard Oil Company (New Jersey) in 1948.

•

James H. Graham, director of unitization for **Continental Oil Company,** retired July 1. Joining Conoco at Houston in 1945 as superintendent of land unitization in the Southern region, he was promoted to assistant production manager in charge of unitization in 1946 and three years later became director of unitization. Previously he was with Carter Oil Company in Tulsa as assistant superintendent of gasoline plant operations and for 20 years was a partner with Ell-Mar Oil Company and Larkin & Graham, independent oil operators. Graham will establish an office in Houston for unitization consulting work and will reactivate the Larkin & Graham partnership operation.



What's Happening

AMONG INDUSTRY ASSOCIATIONS

Oil and Gas Symposia Scheduled for October

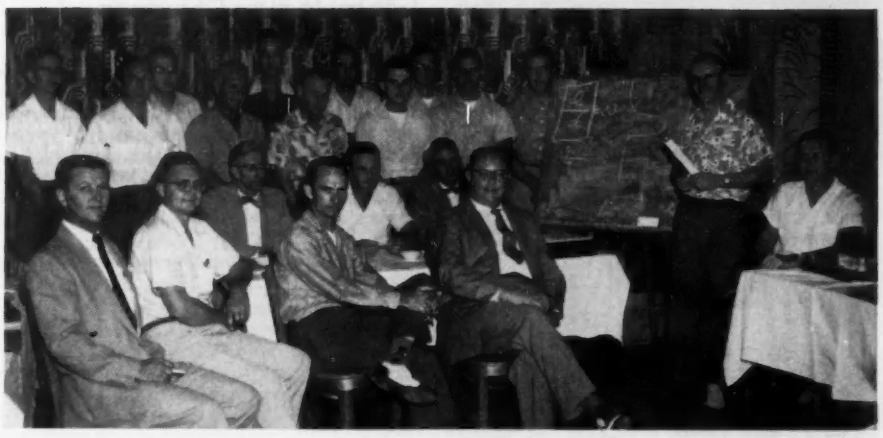
Numerous significant corrosion problems in the oil and gas producing and refining industries are scheduled for consideration during the October 23-26 meeting of South Central region, National Association of Corrosion Engineers at San Antonio, Texas. Symposia on corrosion of oil and gas well equipment, elevated and high temperature corrosion, and six committee meetings on problems in the chemical and petrochemical industries are planned.

Another symposium devoted to the transportation industry will include papers on internal protection of ships, external ship hull protection and chemically deposited nickel alloy coatings for tanks.

Dr. C. N. Gould Honored By Society Field Conference

The Oklahoma City Geological Society will hold a field conference celebrating its thirty-fifth anniversary September 20-22. Theme of the conference will be a study of the Paleozoic rocks outcropping in the mountains of south central Colorado, and their relationship to comparable units in the northwestern Anadarko Basin. The conference also will study tectonic and structural relationships in that basin and adjacent areas, and their contribution to an influence on sedimentation in the basin.

The guide book will be dedicated to the late Dr. C. N. Gould, pioneer Oklahoma geologist, who did much of the early geological work in the northwestern Anadarko Basin.



Engineers and Geologists Attend Workshop

Twelve oil and gas companies sent representatives to a recent Well Log Interpretation School for Petroleum Engineers and Geologists conducted by Jack Grynberg, standing, and Dr. Sylvain J. Pirson, fourth from left on first row, at the Commodore Perry Hotel in Austin, Texas. The school is taught with a minimum of theory and a maximum of practical, every day problems including the re-evaluation of a number of abandoned "dry" holes for possible workover and re-opening. Another logging school of the same type is scheduled for September 10 to 21 in Denver. Requests for information or reservations should be addressed to Jock Grynberg and Associates, 1340 South Santa Fe Drive, Denver 23, Colo.

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Drilling Association Votes $10,000 Education Grant

A $10,000 appropriation for education and training activities has been approved by directors of the American Association of Oilwell Drilling Contractors. Half the appropriation will be made available to the Petroleum Extension Service of the University of Texas, when suitable programs are developed. The other $5,000 will be used by the AAODC Education and Training Committee for the Association's honorariums for college instructors, and other educational projects.

The AAODC has been associated with Petex in oil industry training programs since 1946. Among current AAODC-sponsored events are the School of Drilling Technology in Odessa, Texas, and the series of conferences for drilling executives.

The honorarium awards, established in 1953, have been presented to 17 petroleum engineering teachers in appreciation of their work in furthering student interest in drilling careers.

Gentry Is New Chairman Of Conservation Group

The Conservation Committe of California Oil Producers held its annual election of officers recently. R. C. Gentry was elected chairman for the ensuing twelve months. He has served on the Conservation Committee for four years. At the present time he is chairman of District No. 6, representing operators of the Kettleman Hills district.

The Conservation Committee conducts a program for oil conservation in California oil fields to increase underground recovery on a voluntary basis, which is supported by a majority of the oil operators. The district committee members are elected by vote of the oil producers in the state to represent the various fields and districts.

The other officers elected were first vice chairman, Glenn V. Kersten, District No. 8 (Edison, Mountain View, Tejon Group, Wheeler Ridge, etc.); second vice chairman, H. G. Henderson, District No. 18 (Brea-Olinda, Coyote, Puente, Richfield, Yorba Linda, etc.); and secretary, S. A. Patterson, District No. 31 (Aliso Canyon, Del Valle, Honor Rancho, Newhall-Potrero, etc.)

North Texas A.I.M.E. To Meet in Wichita Falls

A Secondary Recovery Symposium, sponsored by the North Texas Section of A.I.M.E., will meet November 19 and 20 at the Municipal Auditorium in Wichita Falls, Texas.

Pre-registration is urged. The fee for members is $5 and $10 for non-members. Preprints of all papers will be put into a bound volume for everyone registering at the meeting. The bound volumes of the preprints will be mailed after the meeting to all pre-registrants who are unable to attend the meeting. Everyone registering and attending the meeting will receive their bound volumes, tickets and other material at the registration desk.

All hotel and motel reservations will be handled by the Housing Committee, P. O. Box 902, Wichita Falls.

Long Beach City College To Begin Drilling Program

Starting with the opening of school in the fall, the Business and Technology division of Long Beach City College will enter the drilling phase of its current Oil Field Technology program. Courses will be conducted on drilling tools and equipment, drilling practices and problems, California oil field geology, drilling mud control (chemistry), physics (applied mechanics), diesel operation and maintenance, and welding.

The program, which was inaugurated in September, 1955, covers one year on production practices and one year on drilling. Production courses offered included production tools and equipment, elementary geology, petroleum mathematics, production practices and problems, and oil emulsions (chemistry).

H.S.M. Burns to Speak At Desk and Derrick Meeting

H. S. M. Burns, president of Shell Oil Company, will be banquet speaker at the fifth annual convention of the Association of Desk and Derrick Clubs of North America, to be held September 7-8 in New Orleans. Burns will speak on The Romance of Oil.

Sybil Sureck, 1955 association president, will be keynote speaker at the opening session Friday morning, September 7. Headquarters for the convention will be the Roosevelt Hotel.

The New Orleans Desk and Derrick Club, first club to be organized, will be hostess club to the convention.

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Companies

DEEPWATER EXPLORATION COMPANY, recently established for contract drilling of offshore oil wells, will be headed by **B. V. Bock,** of Wichita, Kansas, who will serve as president and chief executive. The new company, with headquarters in New Orleans, is jointly owned by Climax Molybdenum Company, Anderson-Prichard Oil Corporation, Bock and **J. H. Hester.** Hester will serve as vice president and general manager of drilling operations. **J. Taylor,** formerly assistant manager of Gulf Coast drilling for Superior Oil Company, will supervise the Deepwater Tender. **R. J. Loeffler,** formerly with Creole Petroleum Corporation, will serve as exploration manager. Bock announced that the company has acquired an ex-LST which had previously been in coastal service. It is being converted to a non-propelled drilling tender 327 feet, 9 inches long, with a 50-foot beam. It will draw 12 feet. Deepwater also has acquired for operation with the tender a rig capable of drilling to a minimum depth of 15,000 feet.

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ALEX McCOY AND ASSOCIATES and **HERMAN KAVELER** announce consolidation of offices in consultant geology and geological engineering and a change in location of their office to the Herald building, Tulsa. **R. Gordon Humphries** will be resident manager and engineer. Alex McCoy and Associates was the first firm in the country formed to offer complete geological consultant work including engineering and exploration. Consultant only, the firm services the industry with office locations in Casper, Wyo., and Denver, in addition to Calgary and Tulsa.

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TRAHAN EXPLORATION, INC., a new company to engage in offshore drilling in the Gulf of Mexico, has been formed by The American Metal Company, Ltd. and Cerro de Pasco Corporation, large mining companies owning oil interests, and J. C. Trahan, independent drilling contractor of Shreveport, La. Executive offices will be in Shreveport, with an operations office in New Orleans. Delivery of the company's first drilling barge, to be of California-type design, is expected in the fall. Officers of Trahan Exploration, Inc. are **J. C. Trahan,** president; **Thornton Tarvin,** vice president; **H. Danforth Starr,** vice president; **John Payne, Jr.,** vice president; **Michael D. David,** secretary; **Hans Vogelstein,** treasurer; **George H. Cain,** assistant secretary and assistant treasurer; and **Erwin A. Weil,** assistant secretary and assistant treasurer.

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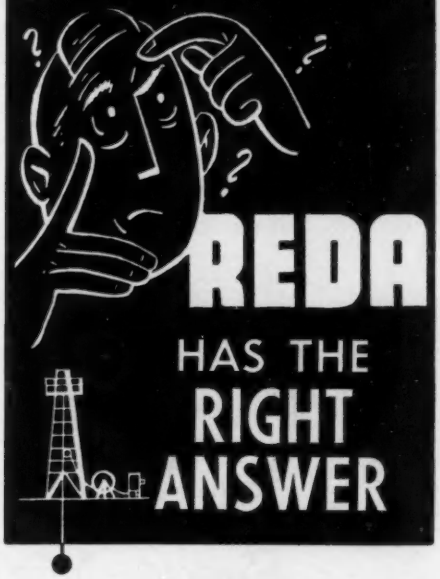
CITIES SERVICE COMPANY'S 32,000-ton supertanker Cities Service Miami was launched in the yards of the Bethlehem Shipbuilding Company recently, becoming the second ship constructed by the company under the U. S. Maritime Administration's "trade-in-and-build" program. The American-flag tanker was christened by Mrs. Henry L. O'Brien whose husband is general counsel and a director of Cities Service Company. The new supertanker will be powered by steam turbines producing 15,000 horsepower and will have a speed of 16½ knots. She is 661 feet long over-all or 630 feet at the loaded waterline. She has a beam of 90 feet and a draft of 33 feet 11½ inches. The Cities Service Miami can transport 18 different

HOW to increase production? Lower Cost?



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Greatly improved overall efficiencies have improved Reda performance as much as 25%; a substantial operating saving.

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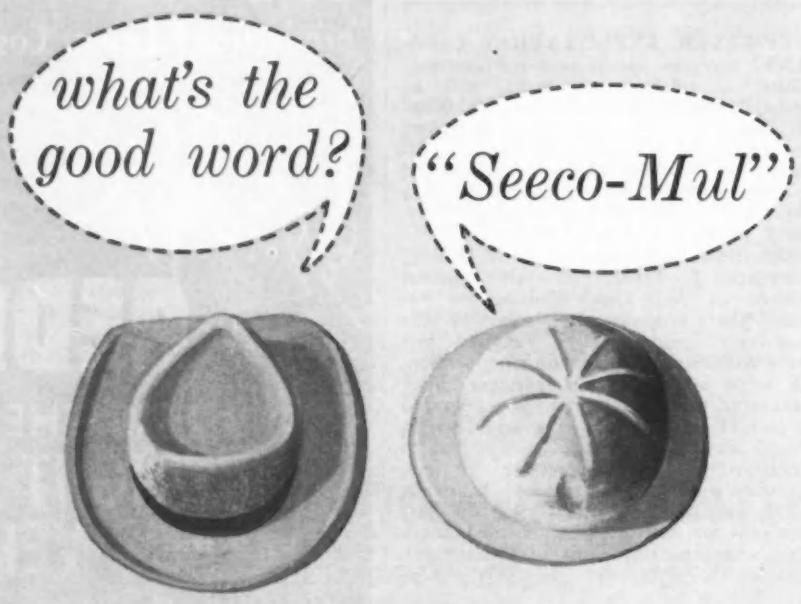

Seeco-Mul Emulsifier makes a good mud better

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Seeco-Mul, added to the system 3-5 lbs./bbl., effectively disperses the oil content in an emulsion mud. It maintains a low filtration rate, has good wall building characteristics, contains excellent properties for maintaining the minimum viscosities in a system, makes better hole conditions, and better completions.

The table below shows actual savings that were effected by using Seeco-Mul. Each example compares a lime base oil emulsion mud and a Seeco-Mul oil emulsion mud in geological comparable formations. If you are interested in savings like these, ask your local mud dealer about Seeco-Mul. Your regular mud engineer can use it without special instructions or extra equipment.

MUD	TOTAL DEPTH	TIME ON BOTTOM	AVG. FT./HRS.	BITS USED	AVG. FT./BIT
Seeco-Mul	9,011	191	47.2	16	563.2
Lime Emulsion	9,150	399	22.9	24	381.3
Seeco-Mul	8,750	225	38.9	17	514.7
Lime Emulsion	8,700	334	26.0	18	483.3
Seeco-Mul	8,286	207	40.0	17	487.4
Lime Emulsion	8,650	373	23.2	20	432.5

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kinds of petroleum products at one time, including various grades of automobile and aviation gasolines, kerosine, home heating oil, industrial oils and lubricating oils.

•

GENERAL PETROLEUM CORPORATION is outfitting a ship for the purpose of obtaining offshore coring samples. The ship, the Torry, was purchased from U. S. Government surplus in Guam and brought to Long Beach Harbor for outfitting. The vessel is 176 feet long and has a 32-foot beam. The offshore coring permit granted to General Petroleum covers an area from the Los Angeles County-Orange County line northward to Point Arguello in Santa Barbara County, California.

•

GREAT BASINS PETROLEUM COMPANY stockholders have approved by an overwhelming majority, acquisition of Lincoln Petroleum Company, Los Angeles; Brown Well Service of West Texas, Odessa; and Lincoln Oil, Gas and Refining Company, Denver. Total assets of the combined companies are appraised at over $10 million and producing properties are located in nine states. Additional selected unexplored leases covering 400,000 acres are held in 12 states and Canada.

•

THE AMERICAN OIL COMPANY has announced that for the second year in a row the company has set aside $35,500 for use during 1956 in aiding privately-financed, four-year liberal arts colleges in 16 eastern states. President Donald J. Smith said that the company was distributing the unrestricted grants through various state and regional associations of privately-financed colleges. The funds will be allocated to more than 140 member colleges in the states of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Ohio, West Virginia, Rhode Island, Florida, Virginia, Maryland, North and South Carolina.

•

SUNRAY MID-CONTINENT OIL CO. and its subsidiary **D-X SUNRAY OIL CO.** have donated a $35,000 law library consisting of 4500 volumes to the University of Oklahoma law school. The books donated to the law school are duplications resulting from the combining of the law libraries of the two firms.

•

The GULF OIL CORPORATION has announced that it will open a new production division office in Denver on September 1. **A. M. Bell, Jr.**, has been appointed division manager of the new office and will be responsible for the activities of Gulf's production department in Montana, Idaho, Nevada, Arizona, Utah, Wyoming, North Dakota, South Dakota, Colorado, western New Mexico and western Nebraska. Bell began his Gulf career with the Gypsy Oil Company in 1925. He initially served as a roustabout in the production department but later the same year became a scout in the Wichita, Kansas, land office. He served in this capacity until he was promoted to land man. Later Bell transferred from the Land department to the Production department in Tulsa as assistant to the general superintendent. He has also served as general superintendent of production, assistant manager of production, crude oil supply and disposition advisor, and manager of exploration of the Tulsa production division.

New Books, Maps and Movies

1956 SURVEY OF OILS, The Financial Post, 481 University Avenue, Toronto 2, Canada. $3.

The 1956 Survey reviews some 600 Canadian oil producing, refining, pipe line and drilling companies within its 372 pages, with a special section providing up-to-date maps of important oil fields including newly-developed areas. In addition to reports on individual western oil companies including data on production, reserves, earnings, dividends, acreage interests and management, the volume provides a five-year price range of oil stock movements and a wealth of statistical material.

A section listing inactive and defunct companies brings to over 2600 the total of companies covered in this comprehensive investment reference book.

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HANDBOOK OF OIL AND GAS LAW, Robert E. Sullivan, Prentice-Hall, Inc., 70 5th Avenue, New York. $11.35.

A comprehensive discussion of basic principles of oil and gas law, their development and applications in present-day operations, this new book concerns the legal aspects of oil and gas and is of importance to lawyers, landowners, lease brokers, oil company personnel, and legislators in states where conservation laws are under consideration. The book concentrates on production and transportation, with greatest emphasis on production and legal aspects connected with it. A discussion of taxation and financing peculiar to these branches of the industry is included.

Other subjects covered include nature of landowner's interest and his protection from unauthorized entry and production, requisites, provisions and interpretation of oil and gas lease, implied obligations of lessee, nature and effect of assignments by a landowner and his lessee, nature and mechanics of government regulation of production, cooperative and contractural plans for the development of separately owned tracts and transportation, taxation and financing.

The Handbook is available through Gulf Publishing Company, Box 2608, Houston 1, Texas.

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GEOLOGY OF THE LATE PALEOZOIC HORSESHOE ATOLL IN WEST TEXAS, by Donald A. Myers, Philip T. Stafford, and Robert J. Burnside, Bureau of Economic Geology, The University of Texas, Austin 12. $2.

Authors of this publication are geologists on the staff of the United States Geological Survey, and the paper is one result of a project sponsored jointly by that Survey and the Bureau of Economic Geology.

The Horseshoe atoll, a subsurface accumulation of fossiliferous limestone which is as much as 3000 feet thick, was deposited during Pennsylvanian and early Permian time in the northern part of the Midland basin, in western Texas. Large quantities of petroleum have been produced from reservoirs in the eastern and southern parts of the atoll.

Major items treated in the paper are characteristics of the reef rocks; stratigraphy of rocks beneath, in, and overlying the atoll; paleontology, with special emphasis on Fusulinidae; structural geology; origin of the Horseshoe atoll including the several theories of atoll origin and their application in this particular atoll; and geologic history during Mississippian(?), early Pennsylvanian, and Wolfcamp times.

Oil and gas reservoirs also are mentioned, and the paper is concluded with an appendix consisting of description of cores from 23 wells in the Horseshoe atoll.

Frontispiece for the volume is a reconstruction of the northern part of the Midland basin in late Pennsylvanian time. Several of the large maps are in color and rocks of Strawn and Atoka age, the Dean siltstone, the Coleman Junction limestone, and the reef complex are used for contouring. One map shows oil fields in the Horseshoe atoll and overlying Wolfcamp rocks. Heliotype plates illustrate the so-called reef rock—calcilutite, calcarenite, calcirudite, shale—and also Fusulinidae of Canyon, Cisco, Strawn and Wolfcamp age.

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MAP OF NORTH DAKOTA, North Dakota Geological Survey, University Station, Grand Forks.

A new geologic map of North Dakota has been prepared by the state's Geological Survey. The map shows bed rock formations, but no glacial deposits. Outlines of the major glacial features are on a smaller map.

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LEAD DEPOSITS IN THE UPPER CAMBRIAN OF CENTRAL TEXAS, by Virgil E. Barnes, Bureau of Economic Geology, The University of Texas, Austin 12. $1.

This paper includes analytical data for deposits of lead and zinc in the Upper Cambrian rocks as well as detailed stratigraphic sections and is illustrated by maps scaled at four inches to the mile. Igneous rocks of Carboniferous or younger age are recognized and the solution history of the carbonate rocks of the Llano uplife is reviewed.

Detailed description is given of the Morgan Creek composite section, Burnet County, and the Klett-Walker section, Blanco County, and logs of churn drill holes of the Eagle-Picher Company in Burnet County are contained in an appendix.

Geologic maps and pace-compass maps of the prospects and particular areas in Burnet, Blanco, Gillespie, Llano and Mason counties illustrate the text. Eight tables contain analyses and insoluble residue data.

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PRINCIPLES OF PETROLEUM CONSERVATION, Interstate Oil Compact Commission, P. O. Box 3127, Oklahoma City 5.

A revision of a 1941 report, this pamphlet is a summary of petroleum conservation related to the regulation of oil and gas production. It is a report of the Engineering Committee of the Interstate Oil Compact Commission, prepared by a subcommittee headed by Professor Benjamin C. Craft, chairman, Louisiana State University.

The report briefly covers certain engineering requirements believed necessary for an effective petroleum conservation program. Items covered in the report include well spacing, well completion, reservoir control, allocation of production and regulatory practices. In addition, the report contains a selected bibliography prepared by the subcommittee.

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GOVERNMENT STATISTICS FOR BUSINESS USE, edited by Philip M. Hauser and William R. Leonard, John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. $8.50.

A second edition, this volume deals with such fields of economic statistics as national income, industry, agriculture, population, labor, prices and transport. It describes content and purposes of the main series of Federal statistics and indicates their applications to the practical decisions required of businessmen and investors.

Fourteen experts contributed to the volume, surveying kinds of data that may be expected from the 1955 economic censuses. Changes that have occurred in the statistical series since 1946 are discussed.

All chapters have been rewritten for this edition. Two new chapters, International Statistics and Some Uses of Sampling and Sampling Aids, have been added.

•

CALIFORNIA OIL FIELDS, Department of Natural Resources, Division of Oil and Gas, 201 California St., San Francisco 11.

This publication, the forty-first annual report of the state oil and gas supervisor, presents special articles dealing with various phases of oil field operations from January-June, 1955. Data, maps and statistics on the Wild Goose, Marysville Buttes, Pleasant Creek and Bowerbank gas fields and the Oakridge, Rosedale Ranch, Wheeler Ridge and Pleasant Valley oil fields are included, plus correlation sections of west side fields of Kern County and production statistics on all California oil fields from January 1 to June 30, 1955. Also published is an index to all previous annual reports issued by the Division of Oil and Gas.

•

HOW TO GET INDUSTRIAL AND BUSINESS PUBLICITY, by Charles E. St. Thomas, Chilton Company, Chestnut & 56th Streets, Philadelphia 39, Penn., $5.

The author covers the important background of the subject and goes on to a complete step by step treatment of what any firm must do to get efficient and effective publicity. How to organize for Publicity, Forms and Working Procedures, How to Release Publicity, Personal Contact with the Press, Measuring and Reporting Publicity, and Relationship of Publicity to Advertising and Sales, are some of the important chapters.

What's Happening

AMONG SERVICE AND SUPPLY MEN

Howard O. Platt

Stephen J. Raphel

Francis J. Robbins

Larry Daniel

W. W. Goode

F. L. Bryan

Howard O. Platt, coordinator of sales and engineering for **Ajax Iron Works,** has been transferred to the company's Mid-Continent district with headquarters in Tulsa. Platt had been in the California area for the past 18 months, coordinating sales and engineering work for the Ajax line of gas engines and pressure pumps.

Stephen J. Raphel, former manager of **Bovaird Supply Company's** Tubular department, has been named assistant to the sales manager to specialize in personnel training and pipe sales promotion throughout the company's stores and sales offices. Raphel's early experience in pipe distribution was with the U. S. Supply Company and Superior Tube Company. He has worked in tubular sales for Bovaird for the past 30 years. **Francis J. (Doc) Robbins,** promoted to manager, Tubular department, will supervise all phases of pipe distribution. He first joined the company in 1924. For several years prior to his new assignment at Tulsa, he was Oklahoma district manager.

Core Laboratories, Inc., announces the recent promotion of **Larry Daniel** to the position of sales engineer in the Lubbock-Pampa-Amarillo area of Texas. Daniel has been employed by Core Lab since 1950. Immediately prior to his current assignment, he was engineer-in-charge of the Lubbock, Texas, laboratory operations.

W. W. Goode has been named assistant manager of the Southeast area in New Orleans for **Schlumberger Well Surveying Corporation.** Formerly, he was Permian Basin division manager. **F. L. Bryan** has replaced Goode in Midland. Goode has served Schlumberger in various managerial capacities in Houma and Lafayette, La.; Tulsa, and Midland. Bryan has served as district manager at Coalinga, Calif., and as manager of the Pacific Valley division at Bakersfield, Calif.

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Jerry Stebbins

Fred Crabbe

Fisher Governor Company, Marshalltown, Iowa, has appointed **Fred Crabbe** and **Jerry Stebbins** sales representatives for New York and the surrounding territory. Their organization will be known as Crabbe & Stebbins Company, with offices located in Englewood Cliffs, N. J., and Albany. Crabbe joined the Fisher sales organization in 1943. Stebbins entered the New York sales office in 1947.

Lynn Maxwell and **William Conway** have also joined this company. Maxwell, who has two years sales experience with Fisher, will devote his attention to gas distribution equipment. Conway has been with Fisher since 1953 and will head the Albany office.

•

International Harvester Company has named **Howard S. Manwaring,** assistant director of engineering since 1953, to the position of director of engineering. In addition to his general administrative duties, he will place special emphasis on motor truck and construction equipment engineering activities. Manwaring joined the Harvester organization in 1934 as an experimenal engineer at the Fort Wayne motor truck plant. He became product and test engineer at Harvester's Tractor Works in 1935 and was appointed manager of engineering, foreign operations, in 1946.

•

James T. Roberts has been named sales division manager for the Cleco division of **Reed Roller Bit Company** in the North Central sales area. Division headquarters are in Chicago. Roberts has had over ten years' experience in the air tool industry and prior to his appointment as division manager, was senior salesman for Cleco.

•

B. F. Maddux has been appointed assistant general traffic manager for **Kaiser Steel Corporation.** His office will be in Oakland, Calif. Maddux joined Kaiser Steel in 1948 and at the time of his promotion was assistant traffic manager, Fontana plant operations.

•

Charles L. Swinden and **Willard J. Hannon** have been appointed sales representatives for **Leschen Wire Rope Division,** H. K. Porter Company, Inc. Swinden will cover the territory in California from Sacramento on the north to Tulare on the south and from East Bay area through most of Nevada. He has just completed a two-months' training program with the company. Hannon's territory includes western Illinois, the City of St. Louis, and most of Missouri. He had seven years of wire rope manufacturing and selling experience with Broderick & Bascom Rope Company.

W. C. Gray

T. H. Patterson

W. C. Gray has been named special sales representative for the Mid-Continent region by **Security Engineering Division,** one of the Dresser Industries. He will be succeeded as Oklahoma division sales manager by **T. H. Patterson.** Gray has been with Security since 1945. He was promoted from salesman to division sales manager in 1947, serving first as Gulf Coast manager and later, as Oklahoma division manager. Patterson joined Security as a salesman in 1948 and since has held the title of district manager and assistant division manager.

•

General American Transportation Corporation announces the transfer of **Norman Wiseman** from its San Francisco office to the sales organization of the Plate & Welding division, with offices in New York City. Wiseman has been with General American eight years in estimating, engineering and erection work.

LARKIN PACKER COMPANY, INC.

WAXAHACHIE, TEXAS

LARKIN ...Through Your Supply Store

PESA

LARKIN LEADERSHIP HAS BEEN EARNED BY YEARS OF DEPENDABLE PERFORMANCE

Reduce your Production Costs *two important ways!...*

Fitted with a flexible and resilient ball guide, the PACIFIC Patented* API Ball Valve Cage lowers your production costs by—

1 **Extending the use life of ball valve and cage.**

2 **Extending the runs between pulling the pump to replace worn valves, seats and cages.**

Why a flexible, resilient Ball Guide?

The difference in the capability of a resilient and a rigid material to absorb repeated shocks without permanent deformation is shown graphically by the unretouched photographs below. The ball valve cages are from the same pump.

HERE IS THE ANSWER:

The PACIFIC steel ball valve cage, with a flexible, resilient ball valve guide bonded to the cage, *costs no more* than a standard steel ball valve cage, *yet it will give three to four times the service.*

A PACIFIC steel ball valve cage fitted with a flexible, resilient ball valve guide retains its original shape after 182 days of continuous operation. The ball valve is in good condition and may be easily removed from the cage.

A standard steel ball valve cage with hardened steel ball valve guides permanently deformed after 49 days of continuous operation. The ball valve cannot be removed from the cage.

*U. S. PAT. NO. 2,682,281

PACIFIC PUMPS INC.

HUNTINGTON PARK, CALIFORNIA

Export Office: Chanin Bldg., 122 E. 42nd St., New York—
Offices in all Principal Cities
Mid-Continent Division: 1221 E. 1st St., Tulsa, Oklahoma

PACIFIC®

DW16

William D. Craig

G. R. Pike

E. N. Wood

Herman E. Schaller

Continental Supply Company has named two division managers and has announced the retirement of another. **William D. Craig** will head the Arkansas-Louisiana-Mississippi-East Texas division with headquarters at Shreveport. The Rocky Mountain division manager will be **Glen R. Pike. Craig** is replacing **E. N. Wood** who retired on June 1. Craig, an employe of the oil field supply company since 1926, has some 19 years' experience in the East Texas area. His former positions with Continental include assistant district manager at Longview and Tyler and division manager in the Rocky Mountain division from 1950. Pike has served as field salesman, store manager, assistant district manager, district manager and in September of last year was promoted to assistant division manager of the Rocky Mountain division. His headquarters will be at Casper, Wyo. Woods, a veteran of 37 years with Continental, retired after spending the past 27 years as manager of the Arkansas-Louisiana-Mississippi and East Texas division.

The McCullough Tool Company has appointed **Herman E. Schaller** to the position of logging manager of their Pacific division. Formerly in charge of Pacific division logging sales, Schaller now will have charge of all aspects of McCullough's radiation well logging program in California. He has had extensive oil field experience, including three years as field engineer with the Conservation Committee of the California Oil Producers Association, one year with The Texas Company, two years with Eastman Oil Well Survey Company and seven years with McCullough.

Dowell Incorporated has transferred **V. W. Grotlisch** to Midland as representative of the company's General Office Sales department. He joined Dowell in 1953 as junior service engineer in the Illinois district, and since has been service engineer, sales engineer and development engineer. In his new assignment, Grotlisch will rep-

resent the general office sales department in West Texas, north and central Texas, the Panhandle and New Mexico.

L. O. (Lee) Weaver has been named Tulsa city sales manager for **Maloney-Crawford Tank & Manufacturing Company.** Transferred from the Wichita Falls office, he has been with the company ten years and has 25 years experience in the tank and separator business. He has been replaced in Wichita Falls by **J. R. Stephens.**

Philip L. Holloway

Thomas H. Evans

Philip L. Holloway has been appointed advertising manager of **Texas Employers' Insurance Association** and **Employers Casualty Company.** He has been with the companies for the past four years. Previous to his assignment to advertising manager, he did sales promotion work for the companion insurance firms. His new duties will include handling all phases of advertising and public relations.

Thomas H. Evans, who has been serving as controller of **Lane-Wells Company,** has been elected secretary of the company and made administrative assistant to the president. For nine years he was controller of Seismograph Service Corporation. Previously he was on the controller's staff at Douglas Aircraft. Since 1954 he has been assistant controller of Dresser Industries, Inc., headquartered in Dallas.

Schlumberger Conducts Millionth Operation

Danbury field, in which the Schlumberger Well Surveying Corporation conducted its millionth operation July 10, was discovered in 1930, one year after the first electrical log was run in the U. S. by Schlumberger.

The millionth operation was on an Humble Oil & Refining Company well, the Danbury Gas Unit Number 6, Well Number 1. The gas unit consists om 185.84 acres.

Discovery well for Danbury was the Number 1 Blakely drilled by the Shell Oil Company. Drilling actually started in 1929 but was not completed until the middle of the following year.

Danbury field has 74 oil wells and 12 gas wells of which Humble operates 43 oil wells and eight gas wells.

Lane-Wells Company Extends Thru-Tubing Cementing Service

Lane-Wells Company's Thru-Tubing Cementing Service, which has been available in the Houston area since early in the year has been extended to include the Southern Louisiana territory.

The equipment used is a 33,600 pound unit equipped with two diesel motors, either of which is capable of handling 3¼ barrels of slurry per minute with a maximum pressure build-up of 6000 pounds. A 6-barrel measuring and a 12-barrel mixing tank with a jet agitator assures homogeneous cement slurry. 13,500 feet of ⅛-inch wire line is used for thru-tubing operations. All tools are available on the truck for running wireline and cementing services including 500 feet of extensible 1-inch aluminum pipe with two 10-foot telescoping joints for sandwashing operation.

Christensen Diamond Products Opens New Gulf Coast Office

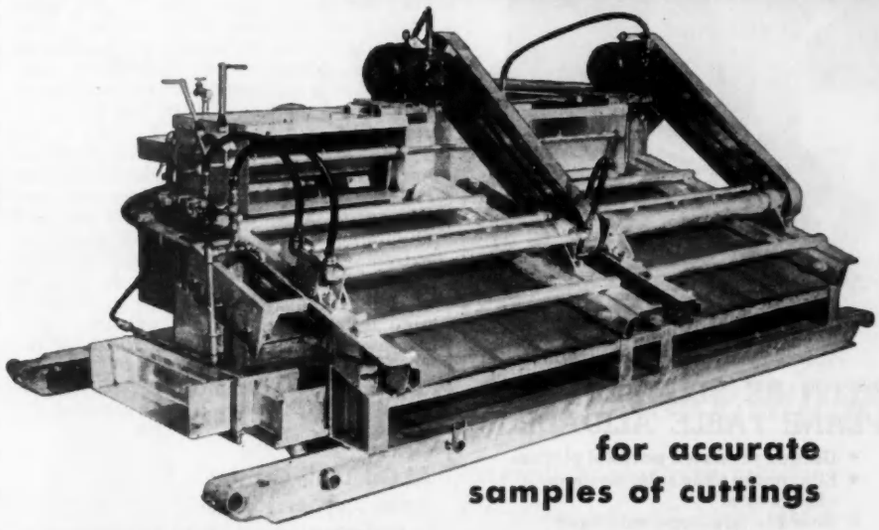
Christensen Diamond Products Company has established a new Gulf Coast division with offices in Houston. Headed by C. Ray Hudson, the division will consist of district offices in Houston and Shreveport and Lafayette, La., including their various sales offices.

Robert T. Barron will head the Shreveport district office, Robert J. Dyar the Houston district, and A. R. Adams the district office in Lafayette. Percy Tinsley has been appointed special representative for the Gulf Coast area and will make his offices in Lafayette.

The company also named Claude Cox, Jr., as the new Mid-Continent division manager with headquarters in Midland, Texas. Cox will direct the activities of the Hobbs, N. M., district office headed by Jack Compton; the Oklahoma City district office headed by Charles McKnight; and the Midland district office under the direction of Ross Jackson.

Thompson

DOUBLE VIBRATING SHALE SHAKER...and SAMPLE MACHINE



for accurate samples of cuttings

The THOMPSON SHALE SHAKER SAMPLE MACHINE offers the operator and geologist one of the best methods available for obtaining accurate foot-by-foot samples of well cuttings.

This THOMPSON DOUBLE VIBRATING SHALE SHAKER and SAMPLE MACHINE is specially engineered for off-shore barges or islands, deep wells, or wells using big volume and high pressure mud pumps. It is available either plain or galvanized, which makes it rust and deterioration-proof on off-shore or coastal duty.

THOMPSON Shakers are famous for their highly efficient service at any depth or flow and for their economical first cost.

Make sure THOMPSON'S on the job for accurate samples and clean mud.

SOLD ONLY THROUGH SUPPLY STORES

Thompson TOOL CO. IOWA PARK TEXAS

For today's competition . . .
TURN TO
KERN
INSTRUMENTS

For great savings of man-hours in the field. Highest precision results in shortest possible time.
DOUBLE YOUR PLOTTING SPEED

Reduce your plane table parties to two men (no recorder needed) . . . increase your accuracy with a
KERN RK SELF-REDUCING PLANE TABLE ALIDADE

- Unique precision parallel plotter.
- Eliminates slide rule, dividers, offset scale.
- New 27x telescope with fixed eyepiece and upright image. Kern AR coated optics.
- Stable plane table head built into tripod.

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Write for Brochure RK 511-S
PROMPT, RELIABLE SERVICE
FACTORY TRAINED PERSONNEL
Kern And Only Kern Offers You the Latest Designs of Dr. Henry Wild

Kern SWISS *The FINEST in SURVEYING EQUIPMENT*
KERN INSTRUMENTS INC.
120 Grand St., White Plains, N.Y.

Accepts Safety Award

More than 1,584,500 man hours worked in 390 days without a lost time injury is the safety record established at the Los Angeles plant of Emsco Manufacturing Company, which has been presented with the Award of Merit from the National Safety Council. Accepting the award from Del Cox, mayor of the city of Huntington Park, are, left to right, S. F. Wiley, safety manager; and J. H. Andrus, plant manager.

Aluminum Pipe Headed For Karachi, Pakistan

The first shipment of aluminum pipe for the oil fields of Karachi, Pakistan, is now traveling aboard the S. S. Hoegh Cape. Race & Race, Inc. of Winter Haven, Fla., are the manufacturers of the pipe. More than 12 miles of the new type aluminum pipe had been sold to the Penrod Drilling Company of Shreveport, La., which has a drilling contract at Karachi. Penrod is a division of the Hunt Oil Company.

The Winter Haven concern has pioneered the manufacture of aluminum pipe for the movement of oil, water and gas. The secret of the new system is a patented aluminum coupling which will withstand extreme pressures and yet is easy to couple and uncouple in the field. Known as Racebuilt Industrial Pipe, the new aluminum lines have been used extensively for the past few years in the oil fields of the U. S.

The pipe was designed under the supervision of A. T. Race, Jr., president of the company.

BJ Oil Tools Creates Sales and Service Company

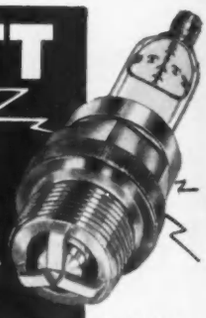
Beginning June 1, sales and service operations for Byron Jackson oil tools and PB products have been handled under the name Byron Jackson Tools, Inc., a new addition to the Byron Jackson group in the Borg-Warner Corporation.

The new corporation was formed to provide faster, more flexible operating procedures. The company will maintain same policies, personnel and locations. Addresses and telephone numbers of headquarters and field offices remain unchanged.

The corporation has no relation to and will not affect activities of BJ Service, Inc., already a separate subsidiary of Borg-Warner.

Officers of Byron Jackson Tools, Inc. are E. S. Dulin, president; Robert Harcus, executive vice president; G. F. Nicolson, vice president and general manager; V. C. Horner, vice president and manager of sales; C. F. Vincent, vice president; Ross Barrett, secretary and treasurer; and Franklin Sloff, assistant secretary and assistant treasurer.

STITT
NEW triple ignitor SPARK PLUGS



INCREASE MAGNETO LIFE

Save on costly magneto overhauls—cut engine "down" time substantially. Stitts last up to 10 times longer—require fewer changes—reduce wear. It's not the plug price, but the "change cost" that's important. Stitts cost a little more—save hundreds of dollars per engine per year. Factory equipment in Clark, Cooper-Bessemer, Worthington, other leading engines.

Free Write for Field Test Reports
Free $1 Gap Gauge

STITT Ignition Company
Columbus 1, Ohio

Get STITTS From:

BELL ENGINE SERVICE	JNO. MULLER CO.
BETHLEHEM SUPPLY CO.	REAGAN EQUIPMENT CO.
CLARK BROS. CO.	WAUKESHA ENGINE & EQPT. CO.
COOPER-BESSEMER CORP.	WAUKESHA-PACIFIC
HOPEMAN EQUIPMENT CO.	WAUKESHA SALES & SERVICE Inc.
INGERSOLL-RAND CO.	WORTHINGTON CORP.

MAGNETO IGNITION SERVICE R. ANGUS (ALBERTA) Ltd. CAN. and Supply Stores Everywhere.

BrakeSol
ELIMINATES COSTLY PARAFFIN REMOVAL METHODS
HOLDS PARAFFIN IN SUSPENSION from FORMATION to REFINERY

BRAKESOL is economical and safe to use, prevents and removes paraffin from the tubing, flow lines, tank bottoms and pipe lines. Effective on both asphalt and mixed-base paraffin.

FOR SERVICE CONTACT YOUR NEAREST BRAKESOL SALES ENGINEER

—EXPORT DISTRIBUTOR—
The National Supply Co
Export Division

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CASPER, WYOMING 2-3453
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FT. MORGAN, COLO UNderhill 7-5981
HOUSTON, TEXAS HOmestead 5-6648
LOVINGTON, NEW MEXICO 6-5954
NEW IBERIA, LOUISIANA EMerson 9-3498
ODESSA, TEXAS 2-2575 7-7192
OKLAHOMA CITY, OKLA. VI 3-6629 WH 9-5561

BRAKESOL, Inc.
P.O. Box 9506 Okla. City, Okla.

New York Shipbuilding, Dresser To Produce Offshore Vessels

A major shipyard and a leading manufacturer of oil well drilling machinery have joined forces for packaged production of specialized ships for the offshore oil industry. Initial contract is for two vessels fully equipped for drilling operations in the Gulf of Mexico.

Teamed in the venture, believed to be the first of its kind, are New York Shipbuilding Corporation of Camden, N. J., second largest shipyard in the U. S., and Dresser Industries, Inc., of Dallas. New York Shipbuilding functions as the shipbuilding department of Merritt-Chapman & Scott Corporation, while Dresser is a manufacturer of oil, gas and chemical equipment.

Under the initial contract totaling more than $5.5 million, they will construct and completely equip two vessels, a 2500 gross-ton drilling tender and a 297-ton cargo-supply ship, for Coastal-Marine Drilling & Construction Corporation of Houston. The latter company recently was organized by Howard S. Cole, Jr., Houston independent oil operator.

The ships, both self-propelled and entirely self-contained units, will operate as a highly mobile team, complete with helicopter port on the tender's bridge deck. Work on the first vessel has started at New York Shipbuilding's 230-acre yard in Camden. Dresser will supply drilling machinery.

Graver Office in Boston To Service New England Area

Graver Water Conditioning Company recently opened a sales-service office in Boston to service the New England area. William A. Homer will be district manager in charge of the office and will handle Graver's line of industrial and municipal water treatment and industrial waste treatment equipment.

Homer has been with Graver since 1952 in the Customer Service and Sales Engineering departments.

Albert Pipe Supply Company Is New Alcoa Jobber

Announced as a new jobber for Aluminum Company of America's light wall and lightweight aluminum Schedule 5 pipe is Albert Pipe Supply Company of Brooklyn. The firm, in business 33 years, will sell Alcoa pipe in its Speed-Lay packaged systems. Each package is made up at the factory with pipe, fittings and couplings, and valves and accessories.

Albert Pipe Supply will sell 2-inch, 2½-inch, 3-inch and 4-inch Alcoa Schedule 5 pipe, as well as the 6-inch construction pipe. Market area includes New York, New Jersey, Connecticut and Pennsylvania.

Shaffer Begins Operations In New Avenal, Calif., Shop

Shaffer Tool Works has begun operations in a new shop and offices in Avenal, Calif., following a formal dedication at the opening of the plant June 8. The shop, under management of Harvey E. Culp, will be used for sales and service of Shaffer Oil Tools to operators and contractors in the Kettleman Hills and Coalinga area.

Kilgore Completes 30 Years

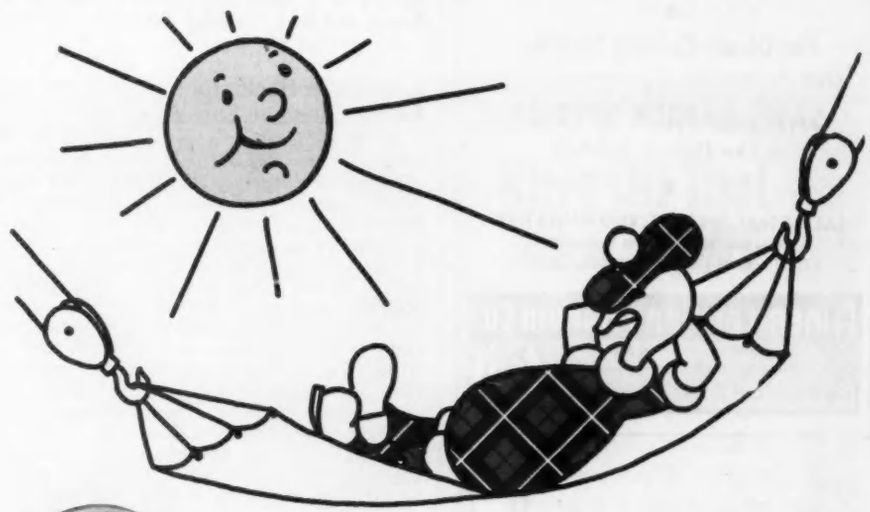
Logan Campbell, vice chairman of Halliburton Oil Well Cementing Company, congratulates Grover Kilgore, right, upon the completion of 30 years with the company. Kilgore is vice president in charge of sales and advertising.

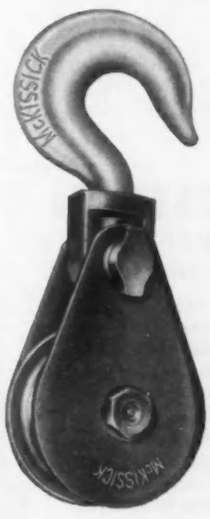
Mack Trucks, Inc. Merges Subsidiaries Under Parent Name

Mack Trucks, Inc. recently merged several of its wholly-owned subsidiary companies under the parent name to provide greater integration of management functions. Mack is listed on the New York Stock Exchange under the parent name, Mack Trucks, Inc.

Mack affiliates that were merged include Brunswick Ordnance Corporation, Mack Manufacturing Corporation, Mack Motor Truck Corporation, Mack Motor Truck Company, Mack Brothers Motor Car Company and International Plainfield Motor Company.

Two other Mack subsidiaries, Mack Trucks of Canada, Limited, and Mack Electronics Division, Inc., will retain present identities.





"LET ~~GEORGE~~ McKISSICK DO IT"

TAKE A LOAD OFF YOUR MIND

Illustrated: CHAMPION SNATCH BLOCK

Drop forged heat treated steel hooks, shackles, yokes and well rounded shells.

Patented opening feature permits easy insertion of line while block is suspended.

For working loads up to 25 tons. Available with hooks or shackles.

Write for catalog of this and other McKissick products.

McKISSICK PRODUCTS CORPORATION
Box 2496 — Tulsa, Oklahoma

McKISSICK BUILDS A BETTER BLOCK FOR EVERY PURPOSE

McKISSICK

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

Drill at Will

SAND-BANUM

Pure Colloidal Concentrate

Ounces Only Once A Week
REMOVE and PREVENT
Boiler Scale and Corrosion

More Power Less Fuel
Fewer Shut-Downs

•

For Diesel Cooling Systems
Use
SAND-BANUM SPECIAL
in the Handy Tablets

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GULF COAST DISTRICT REPRESENTATIVES
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AMERICAN SAND-BANUM CO.
ESTABLISHED 1926
MEADOW BROOK NATIONAL BANK BUILDING
FREEPORT, NEW YORK

Guy Service and Drilling Rigs this Fast Safe Way...

Cut your installation costs, save time and make certain that rigs are safely guyed with Chance Screw Anchors. Tough, all-steel construction stands up in rough use and reuse. Screws into the ground in a hurry. Can be easily removed when the job is done or left intact for future use. Holds up to 11,000 pounds in average soil.

Easily Installed

Send for catalog showing oil industry applications of Chance Earth Anchors.

A·B·CHANCE CO.
CENTRALIA, MISSOURI
TORONTO, ONTARIO, CANADA

Attend School at Research Laboratory

Halliburton Oil Well Cementing Company's electrical well services operators are returning to classrooms at the company's modern EWS research laboratory at Houston to review theory and to study both laboratory and regular field equipment for logging and other EWS services. Recent students at the operators' school included (front row, left to right) Rogers deVerteuil, Trinidad, British West Indies; I. R. Lambert, Pratt, Kansas; and W. J. Smith, Abilene, Texas. On the back row are W. E. Robertson, Liberty, Texas; W. R. Peavy, Duncan, Okla.; W. B. Evans, Gainesville, Texas; and G. F. Gunning, Edmonton, Alberta, Canada.

Calumet & Hecla, Inc. Forms Canadian Subsidiary

Establishment of a new wholly-owned subsidiary in Canada was announced recently by Calumet & Hecla, Inc. The new corporation, to be known as Calumet & Hecla of Canada, Ltd., will be located in London, Ontario, and will represent an investment of more than $7.2 million.

A seamless, non-ferrous tube mill, to be constructed and operated by the new company, will be located on a 60-acre site transferred to the company by Canada Vulcanizer and Equipment Company Limited, another wholly-owned subsidiary of Calumet & Hecla. Land, buildings and improvements for the mill are expected to cost $2.5 million. Machinery and equipment has been estimated at more than $3.5 million. Construction is scheduled for completion prior to December 31, 1957.

The mill will manufacture tubular copper products for the Canadian market as well as for export. The main mill building will be 822 feet long and 104 feet wide with provision for future expansion. A separate building will house engineering, stores and service facilities.

The plant will be staffed largely from present residents of the London area and by key personnel from Canada Vulcanizer and Equipment Company. Operating and manufacturing practices of the new plant will be directed by Wolverine Tube, fabricating division of Calumet & Hecla, Inc.

Officers of the new corporation, in addition to Endicott R. Lovell, president, are H. Y. Bassett, Chicago, D. W. Blend, Detroit, and D. D. C. McGeachy, London, Ont., vice presidents; A. E. Petermann, secretary, and C. C. Jung, treasurer.

Fairchild Aerial Surveys Acquires Florida Firm

Fairchild Aerial Surveys, Inc. has acquired Gray-McKinnon Surveys, Inc., aerial survey firm of Tallahassee, Fla. The new division will continue to operate under the name of Gray-McKinnon, wholly-

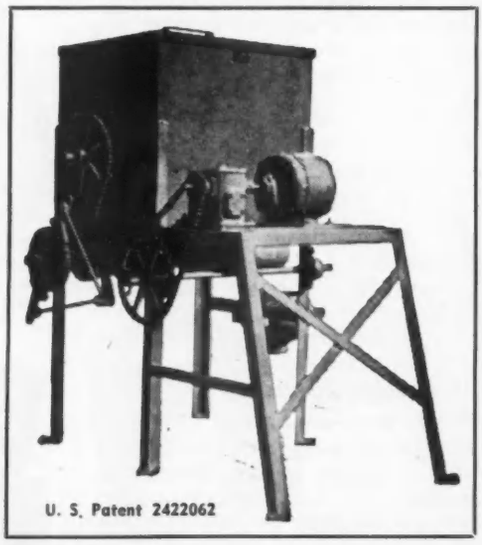
THE WESTERN CHEMICAL FEEDER
the dependable, economical water treater

CHECK THESE FEATURES:

- Used in Oil Well Water Flooding, Municipal Water Treating Plants, Canneries, etc.
- Can be driven by water entering plant for treatment.
- Maintains pre-set water-chemical ratio through a wide rate-of-flow range.
- Adjustable two ways, to feed from a few pounds to several hundred pounds of chemicals per day.
- Also can be equipped with electric motor, or gas engine drive.
- Made to your specifications in various sizes.
- In use the world over.

Whatever your water treating problems may be, investigate the Western Feeder. Write for literature and prices.

For complete description see Page 2777 of the Composite Catalog.



U. S. Patent 2422062

Manufactured By
KEYSTONE SUPPLY CO.

312 E. Cherokee St. Phone LD-10
NOWATA, OKLA.

owned subsidiary of Fairchild Aerial Surveys, Inc. Operations will be moved to larger quarters in Tallahassee where additional equipment will be installed. Gerald McKinnon will remain in the organization as division manager.

The Tallahassee installation is Fairchild's third center of production for photogrammetric engineering, supplementing a branch in New York City and main laboratories in Los Angeles. Sales offices also will be maintained at the Tallahassee address.

Johnston Testers Creates Special Louisiana Gulf Area

Johnston Testers, Inc., announces creation of a special service area for the Louisiana Gulf Coast, formerly part of the Arkansas-Louisiana-Mississippi area. The new organizational plan permits closer supervision and expansion of service.

Max Ready

Max Ready has been appointed area manager. He moved to Johnston Testers in 1949 from Ray & Wolff Drilling Company. After serving as district manager at Shreveport, he transferred to Lafayette in 1953 as sales representative in the Louisiana Gulf Coast. His headquarters will remain in Lafayette.

Formsprag Names R. C. Brown Southwest Representative

Formsprag Company announces the appointment of R. C. Brown Company, Dallas, as sales representative for Texas, Oklahoma and Louisiana. Brown Company was organized in 1948 to serve as manufacturers' representative for mechanical power-transmission and material-handling equipment.

In addition to R. C. Brown, Sr., with Link-Belt Company in various sales and engineering capacities 21 years, the firm has four engineering salesmen handling application and sale of equipment to basic industries of the Southwest through distributors and original-equipment manufacturers. Warehouse facilities, including major stocks of lines handled, are maintained at the company's Dallas headquarters.

Crane and Republic Steel Become Partners in Cramet

Crane Co. and Republic Steel Corporation have become equal partners in Cramet, Inc., producer of titanium sponge. Cramet formerly was a wholly-owned subsidiary of Crane.

Cramet will remain a separate corporation. A new board of directors, consisting of four representatives of each of the parent companies, has been organized. Members are Frank F. Elliott, president; John P. Magos, director of engineering, Paul L. Yates, comptroller and Earl E. Wyatt, executive assistant, all of Crane Co.; and C. M. White, president; T. F. Patton, assistant president and first vice president; Norman W. Foy, vice president in charge of sales; and E. R. Johnson, vice president in charge of operations, of Republic Steel.

Cramet, formed by Crane in 1953, has constructed a plant at Chattanooga, Tenn., which will have a capacity of 6000 tons of titanium sponge annually.

Houston Oil Field Material Opens Office in Lafayette

Houston Oil Field Material Company, Inc. announces the opening of a sales and service office in the Oil Center of Lafayette, La. Located in Lafayette will be C. H. Pollard, assistant general manager, directional drilling in Louisiana and Mississippi; Leon LaBauve, service representative; J. O. (Jack) Duncan, oil field supplies sales; Gordon Harrigan, directional drilling sales engineer.

Allegheny Ludlum Completes Induction Vacuum Melting Unit

Alleghany Ludlum Steel Corporation has announced completion and start-up of a new induction vacuum melting department at its Watervliet, N. Y., Works. The facility is being utilized temporarily as a research and development project. It is expected to be converted to a regular production status as soon as a number of research studies now under way are completed.

The facility complements the production consumable electrode vacuum remelting department installed at the same location last year.

Extensive research and development programs are in progress on new high temperature wheel and bucket alloys for

King Oil Tool
New 75WP
Swivel
Featuring an extremely high ratio of capacity to weight, this sturdy swivel is both efficient and economical for medium-depth oil wells, heavier work-over rigs, and for deep slim-hole and deep water-well drilling.
• Available with bails or elevator shanks
• Alloy steel throughout
• Angular-contact type ball bearings, mounted to assure ample radial stability
• Automatic grease seals retain bearing lubricant
• Stuffing box easily replaced
• Chevron-type packing
Four years of rugged field tests prove superior performance to 4,000 feet with 4½", 5,000 feet with 3½" drill pipe, yet the 75WP is more readily transported than other heavier swivels having comparable capacity.
KING OIL TOOLS
P.O. BOX 15146 - HOUSTON 20, TEXAS - ORchard 3-3421

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

gas turbines. High temperature bearing steels, tool steels, alloys for magnetic applications and alloys for specialized corrosion service also are being studied.

Crenshaw Sales Company Made Distributor of Shipco Inc.

Shipco, Inc., Odessa, Texas, has announced that Crenshaw Sales Company, Houston, has been made exclusive distributor of Shipco spiral pipe wipers in south and East Texas as well as Louisiana, Mississippi and Georgia. All sales are made exclusively through supply stores. The new Shipco spiral pipe wipers are made of a special synthetic compound with reinforced one piece construction for longer life and greater resistance against tearing.

Continental Supply Company Opens New Alberta Store

The Continental Supply Company, Ltd., has announced the opening of a new store at Red Deer, Alberta, Canada. This opening brings the total to ten stores and offices operated in Canada by Continental.

Continental's Red Deer branch will bring more immediate service to the general area of Central Alberta. Fields included in this area are Joffre, Stettler, Erskine, Fenn and Big Valley to the east and the Rocky Mountain House area as well as Sundre, Westward Ho and Harmattan to the west.

Warren A. Pratt, former field salesman at Continental's Liberal, Kansas, store is store manager. The Canadian company's headquarters in Calgary is headed by E. M. Fetzer.

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Ben Sargent, Jr.

H. Hogue

Lufkin Foundry and Machine Opens Offices in Venezuela

Lufkin Foundry and Machine Company, International, has opened offices and warehouses in Maracaibo, Venezuela, it was announced. The officers of Lufkin International are A. V. Simonson, vice president, and H. L. Dyer, secretary treasurer. Ben Sargent, Jr., is South American division manager, and Howard Hogue, who recently was transferred from the home office in Lufkin, Texas, to Maracaibo, will be Venezuelan sales and service manager.

B & B Pipe and Tool Company Purchase Kobe Division

B & B Pipe and Tool Company announces the purchase of the pipe processing division of Kobe, Inc. In addition to two perforating machines, B & B has acquired a license to use the Security flush joint threading patents. The company also will continue to furnish the petroleum industry with pre-packed gravel liners, and the conventional types in standard sizes as well as special units built to customer specifications.

Executive staff of B & B includes Ches Braley, president, and E. W. (Al) Forrow, manager of the new division. Both have been active in field work 35 years. Others who will help direct expanded interests of the company are Tom Worley, sales representative, and Dick Braley, part-owner of the firm, who will divide his time between sales and management.

Color Aerial Photography Inaugurated by Hycon

Color aerial photography service has been inaugurated by Hycon Aerial Surveys, Inc., Pasadena, Calif. The firm is geared to take full-color photographs, develop and process them, make additional black and white prints, transfer images onto geological maps and interpret the data.

Mineral outcroppings, it is thought, are easier to spot on color transparencies, particularly in arid areas where geological land characteristics are not obscured by vegetation.

Penberthy Injector Company Announces Change of Name

Penberthy Injector Company has changed its name to Penberthy Manufacturing Company it was announced by the parent Buffalo-Eclipse Corporation. The change is being made to better identify operations of this Detroit division which manufactures a broad line of electric sump pumps, gages, gage valves, ejectors, eductors, exhausters, cycling jet pumps and other products as well as injectors.

Lettuce, Suits and Hats

LAST YEAR, Americans squeezed millions of heads of lettuce—compared fabrics in countless thousands of suits—and tried on as many hats before they found the *quality* they wanted for the price they were willing to pay.

Yet, in 1955, those same Americans spent $12 billion on one product without a thought of examining it! *That product was gasoline.* The six out of ten families who own cars *knew they could depend on its quality.*

If U. S. consumers think that much of the oil industry's products, then there is no reason on this earth why they can't think as well of the industry itself. And they *will* think as well of the industry, *if* those whose livelihoods depend on its growth will get out and support it.

The oil industry's "good will ambassador" potential goes far beyond its two million employes. There are millions of shareholders who have just as much at stake—as do the thousands of service station dealers.

The time is approaching when every employe—every shareholder—every service station dealer can do his part in winning friends for the industry. That time is Oil Progress Week, October 14-20.

The Oil Industry Information Committee once again has prepared a potent arsenal of true facts about our great industry. The tools to disseminate those facts will be available through movies, speeches, printed matter, placards, billboards, editorials, feature articles, decals and so on, ad infinitum.

The equipment to make Oil Progress Week succeed will be in plentiful supply at every area OIIC office—the *extent* to which it succeeds will be in direct proportion to the number of volunteers willing to work.

The steps toward making Oil Progress Week a tremendous success are simple:

- Make up *your own mind* to help your industry by participating in Oil Progress Week.
- Ask your friends to volunteer with you.
- Contact your nearest OIIC area office and ask what you and your friends can do to help. You may direct your query to any one of the following Oil Industry Information Committee offices, listed according to states:

Rhode Island, Conn., Mass., Vt., New Hampshire, Maine, 100 Boylston Street, Boston 16, Mass.

New York, New Jersey, Room 2206, 1270 6th Ave., New York 20, N. Y.

Delaware, Pennsylvania, Maryland, Virginia, West Virginia, District of Columbia, 1322 Broad-Locust Building, Philadelphia 2, Pa.

North Carolina, South Carolina, Georgia, Florida, 801 Healey Building, Atlanta 3, Georgia.

Ohio, Kentucky, Tennessee, 138 E. Court Street, Cincinnatti 2, Ohio.

Illinois, Wisconsin, Michigan, Indiana, 135 S. LaSalle Street, Chicago 3, Illinois.

Missouri, Iowa, Nebraska, 466 Board of Trade Building, Kansas City 6, Missouri.

Minnesota, North Dakota, South Dakota, 1105 Rand Tower, Minneapolis 2, Minnesota.

Texas, Arkansas, New Mexico, 2909 Maple Street, Dallas 4, Texas.

Louisiana, Mississippi, Alabama, Whitney National Bank Bldg., New Orleans, Louisiana.

Kansas, Oklahoma, Oil Capitol Building, Tulsa 3, Oklahoma.

Colorado, Montana, Wyoming, Idaho, Utah, 626 Patterson Building, Denver 2, Colorado.

Those living in Washington, Oregon, California, Nevada and Arizona should address their queries to Western Oil and Gas Association, 510 West 6th Street, Los Angeles, Calif.

By following the three simple steps outlined above you can help the oil industry take a long step toward being as highly thought of as the fine products it manufactures. *Do your part.*

Lester W. Hall

Clyde W. Truxell

Lester W. Hall was elected executive vice president and a director of the **Eastman Oil Well Survey Company.** Hall started with the Eastman Company in 1951 as a financial advisor. He was for seven years a national bank examiner and later affiliated with the U. S. National Bank in Denver, where he became executive vice president before joining the Eastman Company. Directors also elected for the ensuing year were: **H. John Eastman, Mrs. Phyllis Eastman, Ross E. Wiley, Gordon Jackson, William James, Winfield Cook,** and **Lester Hall.**

Clyde W. Truxell, former works manager of the Detroit Diesel Engine division of **General Motors,** has been appointed general manager of the division. He succeeds **Semon E. Knudsen** who is now general manager of General Motor's Pontiac Motor division. In 1932 Truxell was appointed a member of General Motors research staff and had much to do with the development of the General Motor's two-cycle Diesel first exhibited in 1933. He joined Detroit Diesel as a chief engineer when the division was established in 1937.

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Well organized, well established oilwell drilling contractor desires the management and supervision of oil properties in West Texas, Central Texas, and New Mexico. Can provide complete handling of oil properties, from acquisition to production. No properties too small, and none too large to handle. Inquiries from independents, groups, small or medium sized oil companies invited. Write, wire, or call collect for further information.

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A major integrated U. S. oil company operating in South America has career employment opportunities in a rapidly expanding organization for qualified drilling engineers with 4½ to 8 years of experience in the drilling phase of the oil industry. Candidates must be graduate engineers preferably with a mechanical or petroleum engineering degree. Salary including bonus of approximately $14,000 - $15,800 depending on qualifications and experience. Liberal employee benefits including home vacations with travel expenses. Send complete personal data and work experience resume. Replies will be held in strict confidence. Interviews will be arranged for qualified candidates.

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Major Oil Company in Venezuela seeks capable individual of directing technical end of seismic crew operations; make independent interpretations. Single man with 3 to 5 years experience preferred. Please send details of experience and education to:

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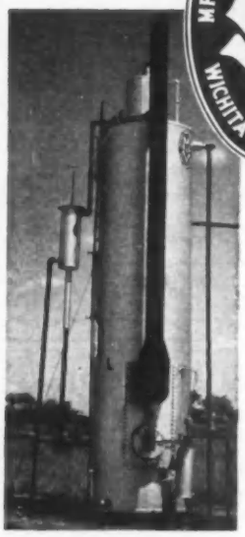

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Very Tactful

A customer sat down at a table in a smart restaurant and tied his napkin around his neck. The distraught manager called a waiter and instructed him: "Try to make him understand, as tactfully as possible, that that's not done."

Said the thoughtful waiter to the customer: "Pardon me, sir. Shave or haircut?"

Sympathy

"I just got out of prison this morning," a traveler told a man on the train. "It's going to be tough facing old friends."

"I can sympathize with you," said the other, "I'm just getting home from Congress."

Bribery

"Golf, golf, golf!" wailed the wife, as her husband, clubs in hand, started for the door.

"I really believe I'd drop dead if you spent one Sunday at home."

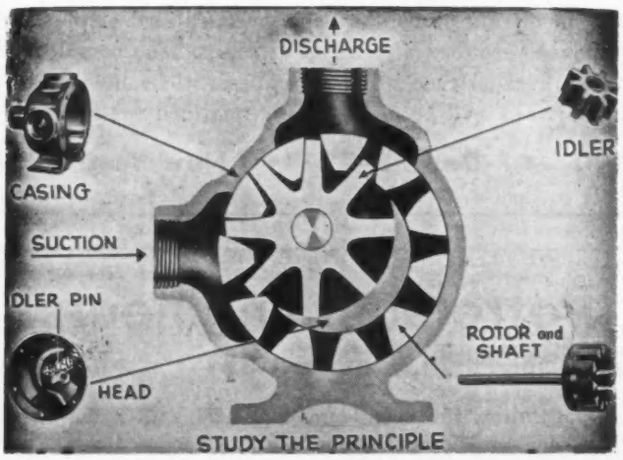
"Now, now," replied the husband. "There's no use talking like that. You know you can't bribe me."

Just One Appendix

"Doctor, please come quick—my wife has appendicitis," came the man's frantic voice over the phone.

"Take it easy, take it easy," the doctor responded. "I remember I took your wife's

Viking Operating Principle



Above are illustrated the major parts of the Viking Pump—casing, head, rotor and idler, separately and assembled. Imagine the rotor and idler in motion operating in a counterclockwise direction. Follow the course of the liquid from point of suction to point of discharge. Reverse direction will operate equally well. We invite your inquiries.

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appendix out less than five years ago. You never heard of anybody having a second appendix, did you?"

"Say, Doc, did you ever hear of anyone having a second wife?" the man shouted his reply.

Just Daddy

It was the little girl's first day at school and the teacher was making out her registration card.

"What is your father's name?" asked the teacher.

"Daddy," replied the child.

"Yes, I know, but what does your mother call him?"

"She doesn't call him anything. She likes him."

Proof

Sandy: "McPherson's a cheat and I'm not playing golf wi' him again."

Andy: "How's that?"

Sandy: "Weel, how could he find his lost ball a yard frae the green when it was in my pocket?"

Philosophy

Footprints in the sands of time were never made by sitting down.

Driving Instructions

Wife asks husband when she is about to drive the car for the first time: "What do I do if the brakes don't work?"

Husband: "Steer toward something cheap."

Battle of Words

Two schoolboys took a strong dislike to each other and the hatred grew more intense as the years passed. One became an admiral in the Navy; the other became a religious man and was made a bishop. Years later they met in a London railway station platform. Both had changed considerably but they still recognized each other. The bishop walked up to the admiral, standing resplendent in his uniform with medals and braid, and asked, "Stationmaster, when does the next train leave for Oxford?" The admiral batted not an eye as he answered: "In half an hour, madam. But in your condition, should you be traveling?"

WORLD OIL

"We may as well turn back. There goes the geologist . . . it's a dry hole.'

Ad in Paper:

"Girl needs a job. Is willing to struggle if given opportunity."

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All these features of Fieldmaster Ball Bearing Motors have been designed to overcome the rugged conditions of Oil Field requirements.

CHECK THESE OUTSTANDING ADVANTAGES.

Heavy Cast base for alignment, stability, heavy duty, double-shielded, prelubricated bearings, reduces lubrication worries, high grade silicon steel in the magnetic circuit reduces iron losses . . . Wide variety of windings provides triple ratings, dual voltages . . . high torque licks heavy starting problems. High slip is available to take care of reciprocating load requirements encountered in pumping.

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CLEAN OUT CHOKING SAND

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Composite Catalog, Page 3369

Write for descriptive price list

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What's New In Equipment

Drilling • Production • Exploration

Shut-Off Valves

Barksdale Valves announces a new line of shut-off valves for the control of oil from 0 to 3000 psi and air from 0 to 2000 psi, available in port sizes of ¼-inch, ⅜-inch, ½-inch, ¾-inch and 1-inch npt. These valves are capable of withstanding velocities up to 60 feet per second without modification.

For ease and convenience in operation, the valve has a hand wheel with position indicator, opening and closing in a 90 degree turn, but may also be supplied with conventional handle. Provisions for panel mounting are included as standard.

This valve incorporates the Shear-Seal principle, which consists essentially of a pressure-balanced, self-aligning tubular sealing ring, the Shear-Seal, in constant perfect contact with an optically flat porting disc or rotor containing the flow passage. This sealing principle has proven especially effective where critical leakage specifications must be maintained. Because flow is through the Shear-Seal and never across sealing surfaces, and because the square external corner of the Shear-Seal wipes the rotor clean, no dirt can enter between the sealing surfaces to cause scoring and destroy sealing qualities. With each actuation the seals actually lap themselves to a more perfect seal; the small amount lapped away after years of service is taken up by back-up spring.

Shear-Seal valves are particularly suitable for throttling; the gradual opening or closing to any desired degree of flow, smoothly and without fighting the fluid pressure, because there are no spools or poppets to obstruct the flow.

For more data, circle **No. E1** on Reader's Service Card, last page this issue.

Electric Drilling Rig Power

General Electric is bringing a complete, standardized line of electric transmission equipment to the oil well drilling rig power system. Engine builders and oil well equipment manufacturers will be supplied with a generator-motor-control package of "building block" design, components of which can be quickly assembled in various combinations for different rigs.

The motor offered is a standard General Electric traction motor modified electrically to include a shunt field. It is rated 600 hp at 900 rpm continuously, and for rapid hoisting duty it can be operated intermittently at 800 hp. Mechanical modifications on the motor include: mounting feet, individual blowers, splash guards, high-temperature insulation, terminal blocks for field and armature connections, and corrosion-resistant metal parts.

Two types of generators are available for drilling rig use. One is the GE-752-J generator, a differential compound machine modified from the standard traction motor, rated 600 hp input over a 1000 to 1200 rpm speed range. It is available with either a single or double shaft extension.

The other 3-field generator, the GT-558-R, shown in the photograph, rates 260 hp input, at 1800 rpm. It is a single-bearing, flange-mounted machine arranged for self-ventilation, and is weatherproof. With this generator multiple groups of smaller high-speed engines can be used to power a drilling rig.

The General Electric packages are offered with two basic control systems. The systems control the motors either by varying the engine speed or by presetting the engine speed and varying the generator field excitation. External controls, all made up of railroad-type components, are contained in two packages. The operator's control console is placed at the driller's station and operates under slight air pressure.

(This item supplements General Electric Company data on Pages 1957-1976 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E2** on Reader's Service Card, last page this issue.

Shot Hole Mud Flush Drill

A new shot hole mud flush drill, the Pilcon 650, manufactured by Piling & Construction Co. Ltd. of Croydon, England, has a rated capacity of 650 feet using a 2⅜-inch drill pipe. The rotary table is designed for four speeds forward and one reverse, 52 revolutions per minute to 335 rpm. It has two drums mounted on a common shaft. Individual multi-plate friction clutches are provided for each drum controlled from the driller's position. Large diameter self energizing brakes are on each drum, and the rated single line pull is 4000 pounds per drum. Its capacity is 700 feet of ⅜-inch wire line on sand reel and 150 feet of ⅝-inch diameter wire line on drill line.

The mast is constructed of solid drawn seamless steel tube, electrically welded and is hydraulically raised and lowered by twin rams. The chain pull-down is actuated by two one-inch A.S.A. roller chains, driven through heliocentric speed reducer direct coupled to a powerful hydraulic motor. The controls are conveniently grouped in a panel at the drillers position. The drill is designed for mounting on a four or five ton four by four truck with full torque power-take-off.

For more data, circle **No. E3** on Reader's Service Card, last page this issue.

Mill Bearings

Link-Belt Company has expanded its line of mill bearings to include bearings for shafts up to 11-inch diameter. The self-aligning feature in mill bearings assures full load carrying capacity, even when the bearing is subjected to shaft deflections caused by heavy shock loads or support inaccuracies. These bearings are contained in rugged steel housings having large machined bases to withstand the heavy pounding encountered in heavy industry. They are capable of withstanding severe radial and thrust loads.

(This item supplements Link-Belt Company data on Pages 2961-2996 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E4** on Reader's Service Card, last page this issue.

Electric Recorder

Martin-Decker has introduced an improved recorder—electrically operated with manifold advantages. First of all, the electric wire is easier to transport and to string than was the high pressure hydraulic hose used on earlier models. But more importantly, there is no severe limitation as to the distance away from the rig that the recorder can be located. The recorder can be situated completely away from the rig's vibration. If desired, it can be powered by an automobile battery.

The instrument combination provides a practical method of preventing loose connections and galled threads, miscounts, and other human and mechanical errors inherent in running casing.

(This item supplements Martin-Decker Corporation data on Pages 3141-3168 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E5** on Reader's Service Card, last page this issue.

Magnetic Mud Cleaner

The magnetic mud cleaner, recently announced by S. R. Bowen Company, removes cuttings and small metal objects having magnetic attraction from drilling mud. The cleaner consists of a base unit comprising a base plate, side plates, pick-up bar and 12 magnetic elements, and a clean-off unit made of a non-magnetic material (brass) comprising a clean-off plate, clean-off handles and 12 clean-off tubes. The clean-off unit is a non-magnetic shell that encases the base unit and is installed when lowered over the base unit.

The cleaner is placed in the mud ditch below the shaker and the side plates turned outward until they contact walls of the ditch. When submerged in the mud ditch, all drilling mud must pass within the field of its magnetic elements.

(This item supplements S. R. Bowen Company data on Pages 729-780 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E6** on Reader's Service Card, last page this issue.

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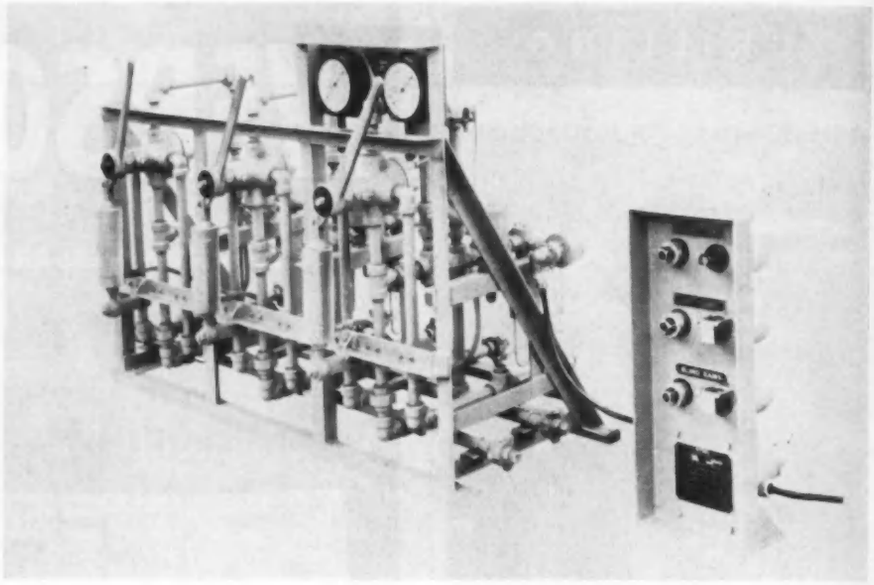


Pushbutton Control Unit

Hydril Company is offering an electric control manifold with pushbutton remote closing unit for fast, easy operation of blowout prevention control systems. With the Hydril pushbutton remote closing unit at the driller's position or at the exit stairway, the automatic pump accumulator and Hydril electric control manifold may be installed at a safe distance from the well. In an emergency, the driller simply pushes the button to shut down the well.

A pilot light beside the pushbutton indicates whether the preventer is open or closed. In multiple-station installations all pushbuttons except that for the primary blowout preventer are protected with swinging covers so that the wrong button cannot be pressed accidentally. As a further precaution, pushbuttons may be used only to close the equipment; to reopen, the valve on the control manifold must be operated manually.

Operating off rig lighting service, the Hydril electric control system does not require a separate power source.

(This item supplements Hydril Company data on Pages 2501-2592 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E7** on Reader's Service Card, last page this issue.

Free-Swivel Mud Gun

Byron Jackson Tools, Inc., announces a new PB heavy-duty Mudjet mud gun which combines free-swiveling with positive setting. Mudjet swivels freely on both the horizontal and vertical planes. Free Swiveling is provided by high-strength balls rolling in heat-treated alloy steel races.

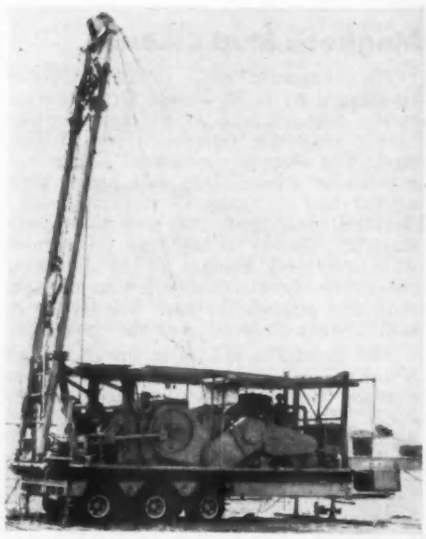
Another exclusive PB feature—the Cam-Lok—emphasizes quick positive setting of the gun in any desired swivel position. This new locking mechanism is easily set and released by hand—no tools are required. One Cam-Lok controls vertical rotation and the other controls lateral setting. The Mudjet gun may be left unattended or may be adjusted while in operation.

(This item supplements BJ Oil Tools data on Pages 907-1004 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E8** on Reader's Service Card, last page this issue.

Portable Spudder Rig

A trailer mounted spudder drill rig owned by the Clock Drilling Co., of Great Bend, Kansas, was recently mounted on a specially designed 25-ton capacity triple-axle low bed trailer manufactured by Transport Trailers, Inc., Cedar Rapids, Iowa, manufacturer of heavy duty trailers for the construction and oil field industry. The triple-axle assembly spreads the load evenly between 12 tires and permits travel on or off the highway. The rig sets 32-inches off the ground.



For more data, circle **No. E9** on Reader's Service Card, last page this issue.

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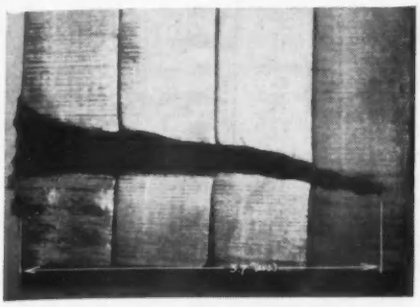


Jet Perforating Charge

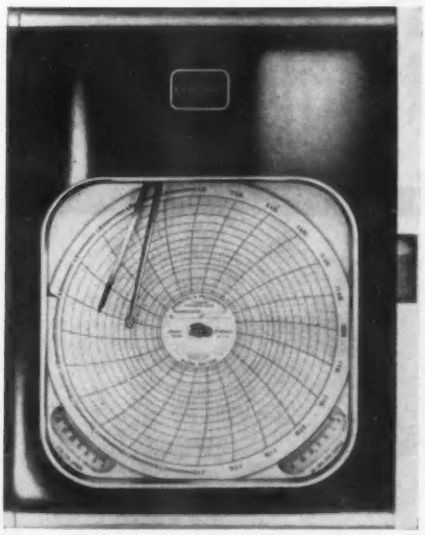
The ROCKET J-II, a jet perforating gun, is being introduced by the Western Company. Proving under the most exacting test conditions to give "all hole—no carrot," Western's ROCKET J-II brings to the petroleum industry an advancement in jet perforating.

Climaxing months of development research and testing by the Western Company were the standard tests supervised by the Perforation Investigation Committee. This group is composed of representatives of 15 major and independent production companies and 9 perforation companies. The certified results of firing the 4-inch J-II under fluid into mild steel test targets is as follows:

Completely obstruction-free perforations.
.61-inch diameter average entry hole.
3.7-inch average penetration.

ROCKET J-II utilizes a completely new design concept to eliminate formation of carrots which plug perforations. Coupled with an exclusive spring loading principle, it produces perforating advantages which producers can not overlook at standard prices. The accompanying illustration of an actual test target demonstrates the validity of the claim—"all hole—no carrot."

For more data, circle **No. E10** on Reader's Service Card, last page this issue.



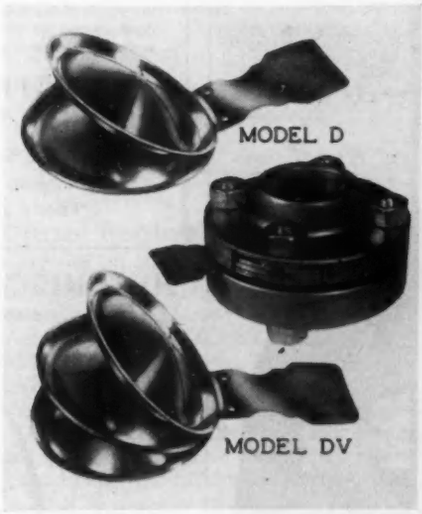
Air Controller

A new Series 500 Air Controller has just been announced by The Bristol Company of Waterbury, Conn. This controller features high stability of control action without loss of sensitivity, coupled with a wide proportional band.

The controller is offered for measuring and controlling such variables as pressure, vacuum, temperature, liquid level, flow differential pressure and mechanical motion. Control modes available include narrow band (on-off), proportional, reset, derivative, and reset plus derivative. Cascade, selective, and ratio control models are also available, as well as program control models.

Among the design features of the new controller are wide proportional band width (½ percent to 400 percent) with easy shift in width, full zero derivative setting on triple mode controller, reset action stops for prolonged deviation from set point under severe load changes, easy reversal of action, and a precision linkage arrangement allowing complete disassembly and recalibration with only one adjustment.

For more data, circle **No. E11** on Reader's Service Card, last page this issue.



D & DV Rupture Disc

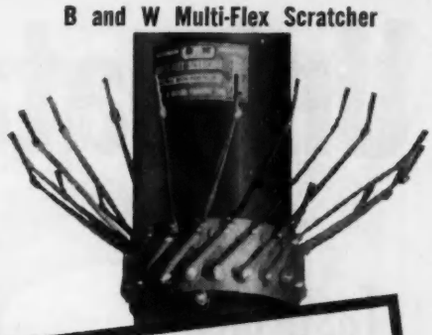
Black, Sivalls & Bryson, Inc., manufacturers of Safety Heads for the protection of pressure systems against excessive overpressure, announces a new type rupture disc that extends the advantage of safety head protection to many installations now operating under pressure, temperature and corrosive conditions too severe for conventional type discs.

The new D and DV Rupture Disc extends the range for high temperature applications, provides maximum service under pulsating or reversing pressure conditions and permits closer operation to rupture pressure. The new D and DV also makes lower minimum rupture pressures possible and gives extended service under pressure surges that approximate the rupture pressure.

(This item supplements Black, Sivalls & Bryson, Inc. data on Pages 649-660 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E12** on Reader's Service Card, last page this issue.

B and W Multi-Flex Scratcher



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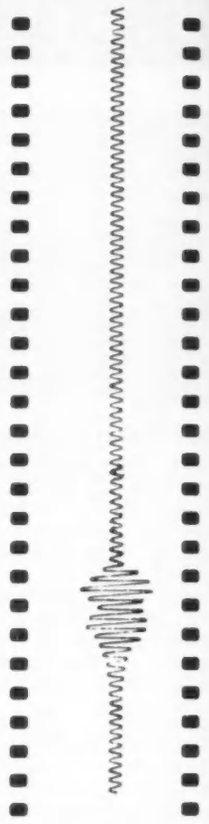
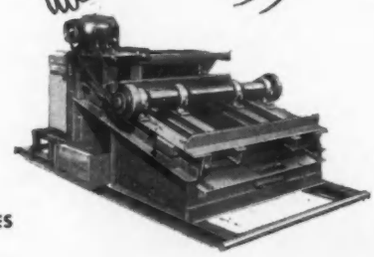


Specimen of log tape indicating saturation with break in zone

HUTCHISON MANUFACTURING CO.
6609 AVENUE U, HOUSTON 11, TEXAS



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New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader's Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Roller Chain Data

Information on one of the most complete lines of roller chain made is contained in Link-Belt Company's latest publication. Included are sections on stock drives, installation and maintenance, lubrication, conveyor chains, casings and other subjects. The illustrated booklet gives all information necessary to choose the right roller chain for a given application.

To get a copy, circle **No. E13** on Reader's Service Card, last page this issue.

Industrial Paint Booklet

"Paints for the Oil Industry" is a 56-page cloth-bound book prepared by International Paints Ltd. The volume presents comprehensive information on the subject in a manner of use to engineers, mechanical supervisors, executives and stores men. Included is a concise discussion of steel surface preparation procedures.

To get a copy, circle **No. E14** on Reader's Service Card, last page this issue.

Tubing Heads Folder

National Type "W" tubing heads are described in a bulletin recently released by National Supply Company. Designed for use with a variety of tubing hangers, bonnets and supports at pressures of 1000, 2000 or 300 psi, these heads have 2-inch, 2½-inch and 3-inch threaded outlets and eight sizes of bottom threads between 4½ and 8⅝ inches.

To get a copy, circle **No. E15** on Reader's Service Card, last page this issue.

Wire Rope Manual

A revised edition of Jones & Laughlin Steel Corporation's manual on wire rope has been completed. Entitled "Wire Rope Is a Machine," it contains extensive information on selection, installation and best operating practices for wire rope.

Included in this revised edition is new material on the applications of JalKlamps and JalFlex Slings.

To get a copy, circle **No. E16** on Reader's Service Card, last page this issue.

Oil Industry Catalog

The Gulf Publishing Company has released its latest catalog of books of interest to all in the petroleum industry. The catalog contains descriptions on over 165 titles. Subjects covered include drilling, production, geology, reservoir engineering, refining, safety, petroleum chemicals, pipe lines, corrosion, distillation, design, law, patents and taxes.

To get a copy, circle **No. E17** on Reader's Service Card, last page this issue.

Oil Field Equipment Catalog

Skinner Brothers Company has issued an up-to-date catalog on its line of oil field specialities. Changes in prices and quality are noted.

To get a copy, circle **No. E18** on Reader's Service Card, last page this issue.

Diesel Engine Bulletin

ALCO Products, Inc., has announced publication of a 14-page bulletin on the company's new "family" of diesel engines —the 251 series—available in ratings from 550 to 2400 horsepower. The engine series includes the six-cylinder in-line model and the 12- and 16-cylinder Vee-type engines.

The two color bulletin employs wide use of photographs of individual engine components, production line views, and features a cross-section cutaway of the Vee-type engine. Also included are dimension charts and specification tables for the three engines.

To get a copy, circle **No. E19** on Reader's Service Card, last page this issue.

Oil Well Equipment Catalog

Rolo Manufacturing Company has published a new oil well separating and metering equipment catalog. Wellchecker units separate oil, gas and water; Rolocheck meters accurately meter oil and water. Skid-mounted, trailer-mounted and permanent units are shown. It includes complete descriptive data and full information on operation, applications and economic advantages. The 2-color, completely illustrated, 24-page Catalog 56W also illustrates and describes automatic samplers. All accessories for well separating and metering units are also illustrated and described.

To get a copy, circle **No. E20** on Reader's Service Card, last page this issue.

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